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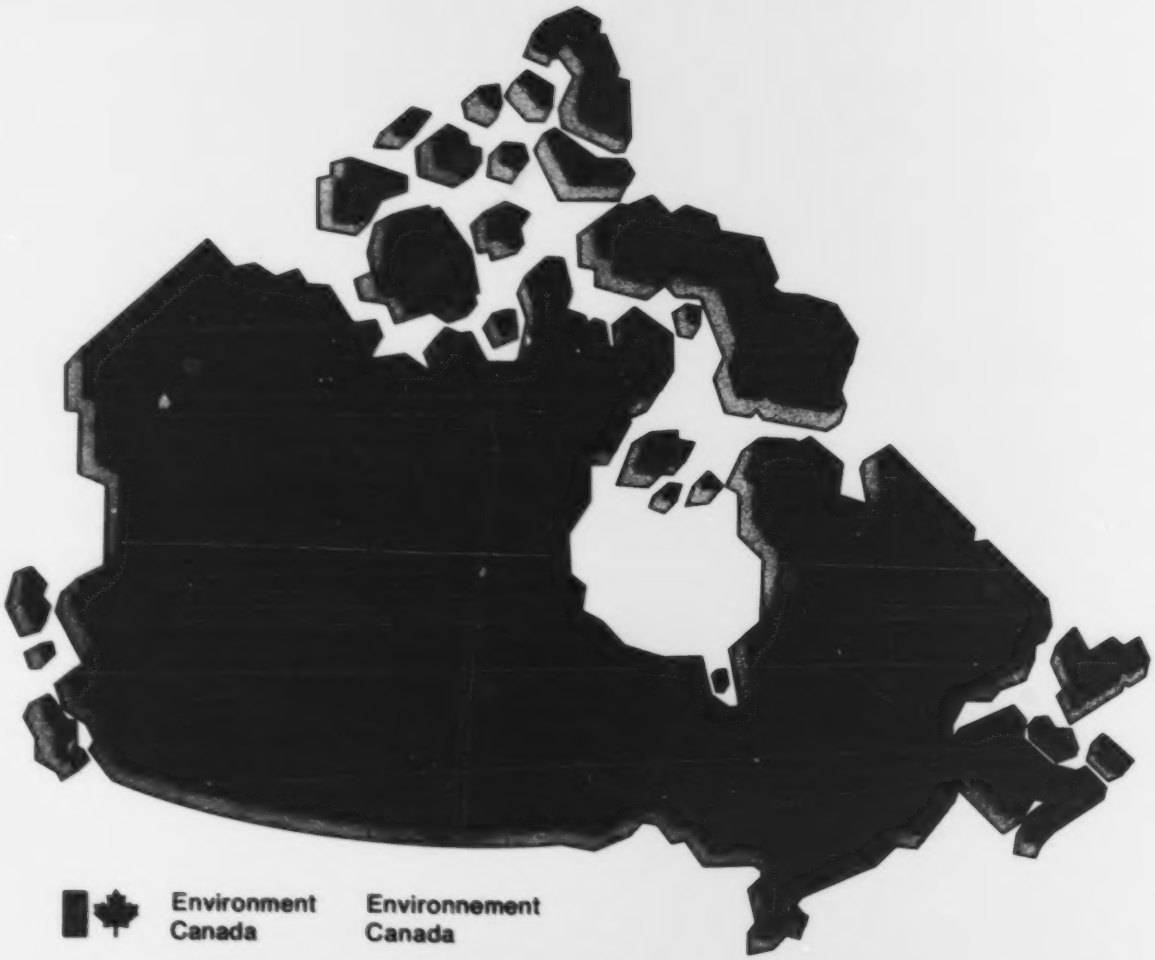
LAND IN CANADA'S URBAN HEARTLAND



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LAND IN CANADA'S URBAN HEARTLAND

by

Maurice Yeates

Land Use Policy and Research Branch
Lands Directorate
Environment Canada

Ottawa
November, 1985

LAND USE IN CANADA SERIES

The *Land Use in Canada Series* is designed to address major land-use issues and problems in Canada. The series, produced by and for the Lands Directorate of Environment Canada, examines the causes and consequences of major land problems and land-use trends throughout Canada and the role of various government programs in eliciting solutions.

Incorporating the earlier series entitled *Land Use Programs in Canada* which reviewed the land-use programs of Canada's ten provinces and two territories, the series examines, from a national perspective, activities affecting the use of Canada's land.

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PREFACE

The basic theme of the *Land Use in Canada Series* is that the land resource is perhaps the most vital component of the economic base and wealth of the nation. This particular volume analyses the impact of urban development on the rate at which land is transferred from rural to urban uses in central Canada, an area defined as the heartland or core of the nation and its economy. This is an extremely important issue for a number of reasons.

First, although the heartland region between Windsor and Québec City comprises less than one-seventh of the occupied area of the country, it contains more than one-half of the highest quality (Class 1) land for agriculture, and more than one-fifth of all types (Classes 1, 2, and 3) of land that are most suitable for agricultural production. This relatively small area is responsible for the production of about one-third (by value) of the agricultural output of the country.

Second, this core region contains more than half of the population of the nation, more than 80% of which is located in extensive urban regions. The urban component of the Windsor-Québec City axis is rapidly expanding even though the population growth rate is now fairly low when compared with that of two decades ago. The expanding urban population is consuming increasingly more rural land for urban purposes, and much of this consumption (measured by land-consumption rates) occurs in areas containing the better quality land. In short, land that is good for agriculture appears to be preferred for urban development.

Third, although this part of Canada is the most highly urbanized part of the nation in terms of aggregate population, density, number of metropolises, and regional integration through a variety of different means of transportation, there are other parts of the country that are developing similar concentrations of people and economic activities. Examples of such developing incipient macro-urban regions in the hinterland are the Strait of Georgia Urban Region (Vancouver/Victoria), which in reality is trans-national because it is part of an urban agglomeration extending to Seattle, and the Calgary-Edmonton Corridor. Variations in rates of development between the heartland and the hinterland influence rates of urban growth, and hence rural/urban land conversion in the hinterland. Trends in the heartland therefore provide considerable insight into similar trends in developing urban agglomerations in the rest of the nation.

The monograph focuses on the factors affecting the rural-to-urban land-conversion rate over time. Urban development, or the major demographic, economic, social, and cyclical events influencing urban growth, is treated as the independent variable, while the land-consumption rate is the dependent variable. This approach leads to three general conclusions: (1) land-consumption rates are increasing over time but at a decreasing rate; (2) even though total population growth rates are declining, the expansion of urban areas (through both suburban and ex-urban developments) is resulting in large amounts of land being transferred from rural to urban uses; and (3) the apparent contraction of the core to central and southwestern Ontario is having a particularly dramatic effect on rural/urban land conversions in that part of the nation.

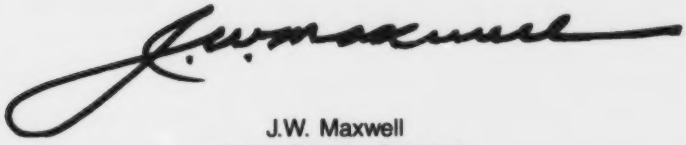
The "bottom line" on this land-consumption issue concerns estimates of the amounts of land transferred from rural to urban uses in the 1970s, and projections through to the year 2001. It is estimated that in the 1970s the Windsor-Québec City axis lost, through direct and indirect consumption of land for urban purposes, more than 400 000 hectares of rural land, and between 1981 and 2001 almost another

700 000 hectares will be lost. During the last three decades of the century, urban growth will have consumed more than 1 million hectares of land, and nearly all of this has occurred in the part of the axis containing the most suitable soils for agriculture.

The study concludes with some discussion of various land-use monitoring and cost/benefit studies that should be continued and/or undertaken to improve knowledge about the rural/urban land-conversion issue and policy alternatives. As far as monitoring is concerned, international comparisons indicate that the Canada Land Use Monitoring Program (CLUMP) is providing good quality information, but that a longer time series is required. In a policy-oriented context, various procedures for enhancing the operation of the land market should be investigated.

Land in Canada's Urban Heartland continues the program of the Land Use Policy and Research Branch of the Lands Directorate, which is designed to inform individuals involved with policy questions, and the public in general, about important matters related to Canada's resource base. This particular study is forward-looking in that it attempts to link the major factors influencing urban development in the heartland of the Canadian economy to rural/urban land conversion. The monograph provides information concerning current trends, a prognosis, and recommendations for immediate attention.

The independent research and analysis conducted by Maurice Yeates were made possible by a grant from the Social Sciences and Humanities Research Council of Canada. The Lands Directorate is pleased to publish this report because it contributes to a better understanding of urban pressures that affect the demands for and use of Canada's land resource.



J.W. Maxwell
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ABSTRACT

The paper examines the reasons for, and the effects of, the rate of consumption of good agricultural land by urban development in the economic heartland between Windsor and Québec City. It finds that, while population growth rates are falling, the rate of expansion of urban areas continues to increase, but more slowly than in the recent past. It suggests that the heartland is contracting to central and southwestern Ontario, where the loss of agricultural land is increasingly pronounced. The paper projects current trends to the end of the century and predicts that more than one million hectares of Canada's best agricultural land will be consumed by urban development between 1970 and 2001. The paper proposes specific improvements to the current methods of monitoring land use and a model for a more prudent operation of the land market.

RÉSUMÉ

Sont examinés les causes et les effets du taux de consommation des bonnes terres agricoles par l'expansion urbaine dans l'axe économique Windsor-Québec. Alors que les taux de croissance de la population diminuent, le rythme d'expansion des zones urbaines ne cesse d'augmenter, quoique moins rapidement qu'il y a quelques années. Il semblerait que le corridor urbain se resserre vers le centre et le sud-ouest de l'Ontario, où la perte des terres agricoles s'accentue. Des projections des tendances actuelles jusqu'à la fin du siècle ont été effectuées. On prévoit que plus d'un million d'hectares des meilleures terres agricoles canadiennes seront consommées par les villes entre 1970 et 2001. Des améliorations aux méthodes actuelles de surveillance de l'utilisation des terres sont proposées, ainsi qu'un modèle visant un fonctionnement plus prudent du marché foncier.

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But, above all, I continue to be grateful for the positive and supportive environment that is created by my family/Queen's/and department. The members of my family, in particular, retain a strong sense of humour about the various situations that arise in research and writing which, for some strange reason, I think are serious.

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INTRODUCTION

A characteristic of human habitation particularly evident in this century is the formation of extensive macro-urban regions, or megalopolises (Gottman, 1961; 1976). These are not single large metropolises of a few million people, but extensive urbanized regions consisting of a number of large metropolises as well as smaller settlements. In the more densely-populated parts of these macro-urban regions, the metropolitan areas and settlements are conterminous, giving rise to a galactic (Lewis, 1983) arrangement of shopping centres, industrial concentrations, office complexes, and city centres, connected physically with each other and with residential areas by different means of transportation. A megalopolis consists of a number of metropolises and galactic arrangements of this type that are highly connected with each other through various forms of transportation and electronic methods of communication.

A notable feature of these megalopolises is that they are not completely urbanized. Between the urban concentrations, there are extensive areas that are less densely populated, which Bryant, *et al.*, (1982) refer to as the "city's countryside". The land in the less heavily-populated areas is used for agriculture, recreational purposes, transport facilities, gravel pits, country residences, and so forth, and serves as a location where future urban development may occur. A particular characteristic of the open land within macro-urban regions is that it is under continuous and often intense pressure from the immediate urban environment; this pressure can arise *directly* from contiguous urban expansion which leads to the transfer of land from rural to urban purposes, or *indirectly* from such non-contiguous, urban-oriented uses as those occurring along major highways or from wastes generated by urban activities (Simpson-Lewis, *et al.*, 1983).

In an earlier study (Yeates, 1975), the area between Windsor and Québec City was defined, on the basis of major spheres of urban influence (Bailly and Polèse, 1975; Ricour-Singh, 1979), population densities, and physical features, as a developing macro-urban region (*see* Map 1). This area was identified as forming the core, or the heartland, of the Canadian economy, so it was described as the axis around which the country is bound together. This urbanized area in central Canada consequently plays quite a different role from the much smaller "hinterland" urban corridors defined for Calgary/Edmonton (Smith and Johnson, 1978) and Vancouver/Victoria (Gibson, 1976). The purpose of this particular study is to examine, in general terms, the current and possible future impact of urbanization (the independent variable) on land (the dependent variable). The nature of the relationship between these two variables is discussed in the immediately ensuing sections. Urbanization in the Windsor-Québec City axis is then presented in terms of the changing relationship between the heartland and the hinterland, and the changing patterns of urban development within the axis area.

Map 1

Location of Major Features and Cities in the Windsor-Québec City Axis

◀ Edward W. Manning

URBANIZATION AND ITS IMPACT ON LAND

The question of the extent to which urban uses are encroaching upon valuable agricultural land has been of deep public concern in Western Europe and North America for some time (Clawson, 1971; Best, 1981). The issue has come forward in the United States and Canada over the past two decades as a result of rapid suburban growth in the 1950s and 1960s, and increasing awareness of the special role that North America is playing, and will increasingly have to play, as a provider of food and certain agricultural products for the rest of the world. In Canada, this general concern (Gierman, 1978; Pierce, 1981) is reflected in studies that have focused on planning problems related to the urban fringe (Russwurm, 1977) and the consumption of high quality land (Krueger, 1978). Environment Canada has played a valuable role in this discussion by providing a national monitoring service on land-use change within urban regions, as well as by publishing individual resource papers (Gierman and Warren, 1981).

Theoretical Relationships

Most of the studies concerned with the amount of land that has been and is being used for urban purposes are collected and interpreted on the basis of the dynamics of three simple relationships. The first is that, in an urban area, population densities tend to be highest around the centre of the city and decrease toward the periphery. At the edge of the city, "urban" population densities are generally close to but somewhat higher than the "rural" population density that is supported by an agricultural economy. Thus, the theoretical limit of an urban area is the line where the population densities are equal to those generated by an agricultural (or rural) rather than an urban economy.

This first relationship demonstrates the difficulties in measuring the extent of an urban area and the reason for the great interest among researchers in urban fringe studies (Beesley and Russwurm, 1981). In Figure 1*a*, the solid line represents a graph of urban population densities, and the wavy line the general level of rural population densities. If the urban area is assumed to have a population of one million people, and the average amount of land consumed by the urban population, or the land-consumption rate (LCR), is 30 hectares/1,000 people, then the theoretical limit of the city (if it were perfectly circular) would be 9.8 kilometres (*see* Table 1). The difficulty, in terms of measurement, is that the population supported by an urban activity is not in fact instantaneously replaced by a population supported by rural activities, because economic pursuits often merge not only between neighbours, but also within the same family and with individuals (for example, part-time farmers). Furthermore, urban expansion is usually not continuous, since it often leap-frogs over rural spaces for a variety of reasons, such as the availability of land for development.

The second relationship is that urban population densities are decreasing over time, and the general urban population-density curve is flattening out. This is illustrated by the broken line in Figure 1*a*. Urban populations tend to consume more space per person, and this trend can be related to space preferences arising from greater wealth and individual independence. The broken line in Figure 1*b* illustrates the effect of a higher land-consumption rate (40 hectares/1,000 people) on the theoretical limits of a city of one million people.

The trend for land-consumption rates to increase over time means that, even if the population of an urban area remains static, there will still be an increase in the consumption of rural land for urban purposes. The recent rapid increase in transportation costs is not materially

Figure 1
Theoretical Relationships

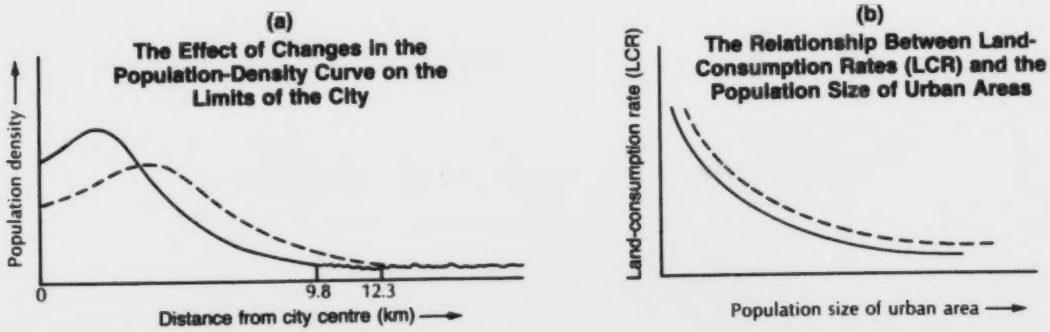

(a)
The Effect of Changes in the Population-Density Curve on the Limits of the City
Population density
0
9.8
12.3
Distance from city centre (km)
(b)
The Relationship Between Land-Consumption Rates (LCR) and the Population Size of Urban Areas
Land-consumption rate (LCR)
Population size of urban area

Table 1

The Area and Theoretical Limits of a City for Two Land-Consumption Rates (LCR) and Two Urban Populations

LCR ha/1,000	Urban Population	Area of City (ha)	Theoretical Radius (km)
30	1,000,000	30,000	9.8
40	1,000,000	40,000	11.3
40	1,200,000	48,000	12.4

reducing this rate of decentralization, because people are simply substituting more energy-efficient transport (Melvin and Scheffman, 1983). If decentralization combines with an increasing urban population and higher land-consumption rates, the outward spread of the city accelerates. For example, Table 1 demonstrates that a 33% increase in the land-consumption rate combined with a 20% increase in the urban population will result in a 60% increase in the urban area.

The third relationship is between the average land-consumption rate and the size of a city. Large urban areas tend to be more compact and have higher average population densities (or lower land-consumption rates) than urban areas with smaller populations. The primary, though by no means only, reason for this is that competition for more accessible locations (to employment opportunities, shopping facilities, social-recreational activities, and so forth) in the more populated cities forces up land prices and rents, which can only be afforded with higher densities of use. This higher density permits more efficient use of various means of public transportation, which in turn facilitates higher densities. The general relationship between land-consumption rates and the population size of an urban area is indicated by the solid line in Figure 1*b*, while the broken line demonstrates the shift in the LCR that occurs over time as a result of the decentralization illustrated in Figure 1*a*.

Recent Trends

The best way to obtain estimates of land-consumption rates is through studies of individual urban areas, using detailed land-use analyses and population counts for specific time periods within the framework of a well-designed spatial sample. Urban areas defined on the basis of political boundaries, or census units, cannot be used because most cities are often either grossly over- or under-bounded in relation to the real limit of their built-up area. Lack of sufficient attention to measurement problems can result in misleading information such as that generated by the Soil Conservation Service of the United States Department of Agriculture, and used in the Final Report of the National Agricultural Lands (NAL) Study. The Final Report estimates that while the U.S. "lost" 1.1 million acres (445 000 hectares) per year to urban uses in the 1958-1967 period, the "loss" was 2.8 million acres (1.1 million hectares) per year in the 1967-1977 period. This latter figure, which has been quoted widely (Fletcher and Little, 1982), is considered by many observers, for example Simon and Sudman (1982), to be a gross exaggeration.

In contrast, the study undertaken by Warren and Rump (1981) is based on a detailed analysis of land use and population change in 80 urban-centred regions across Canada, and the information tabulated provides a more reasonable basis for estimating changes in land-consumption rates. The inventory involves urban areas with populations greater than 25,000 in 1976 and includes not only the urban area, but also the urban fringe and small settlements located within the fringe area of each agglomeration. Information for 1966 and 1971 was also obtained for as many of the same urban agglomerations as possible using details from earlier studies. It is therefore possible to estimate from this inventory the direct urban consumption of rural land for 41 urban agglomerations located in the area between Windsor and Québec City.

The hypotheses examined with this information are incorporated within the relationships summarized in Figure 1*b*:

(1) Land-consumption rates decrease with city size, but at a decreasing rate. This can be represented in model form by the equation — $LCR_i = A/Pop_i^b$ (or log LCR_i = log a – b log Pop_i), where "A" is the intercept, "b" the slope, and "i" is a marker for the 1 to 41 urban areas;

(2) As a result of decentralization, average land-consumption rates increase over time. This is represented in Figure 1*b* by an upward shift of the curve over successive time periods.

The outcome of this analysis is presented in Table 2, with graphs drawn on the basis of the estimated parameters displayed in Figure 2*a*. The results for each time period indicate that land-consumption rates do decrease with city size at a decreasing rate. This is exemplified by the parameters and high levels of statistical significance (t_b) of the slopes of the curves. The arithmetic version of the 1976 curve is presented for illustrative proposes in Figure 2*b*. Although the relationship between land-consumption rates and city size is statistically significant for each time period, the strength of the relationship is not great, since the R^2 values are all less than 50%. Land-consumption rates for smaller urban agglomerations can be extremely variable (*see* Figure 2*c*), because measurement problems are magnified in the results for settlements of less than 50,000 people.

Land-consumption rates in the axis have also been increasing over time. This is exemplified by the increase in value of the intercepts (log A in Table 2) and the increase in value of the weighted means. It should be noted that, while the weighted means are good summary indicators, they are calculated on the basis of all the data and are therefore influenced by values for the largest urban areas. The shift in the resulting curves is plotted in Figure 2*a*. The curves are not significantly different from each other, because neither the intercepts nor the slopes differ statistically significantly from each other over successive time periods. However, the trend in the intercepts is in the predicted direction, and the change in value of the slopes suggests a strengthening of the relationship over time.

The general conclusion, therefore, is that urbanization is consuming land at an increasing rate in the axis area. The land-consumption rate is not static, so if the urban population increases, the amount of land consumed for urban purposes increases at a greater rate. For example, the data indicate that, between 1966 and 1976, a 1% urban population growth was associated with a 1.5% direct increase of land in urban uses. The population growth of urban areas has a disproportionate effect on rural/urban land conversion, and estimates of the future impact of urban development on the land resource require an understanding of the various factors influencing urbanism.

URBANIZATION IN THE CORE/ PERIPHERY MODEL

The Windsor-Québec City axis has been described as the economic and geographic "core" or "heartland" of Canada (Simmons, 1979; McCann, 1982). Because this role affects urban development within the axis, it is important to have some understanding of what is meant

Table 2

The Relationship Between Land Consumption and the Population Size of Urban Agglomerations, 1966, 1971, and 1977: Parameters and Weighted Mean LCRs

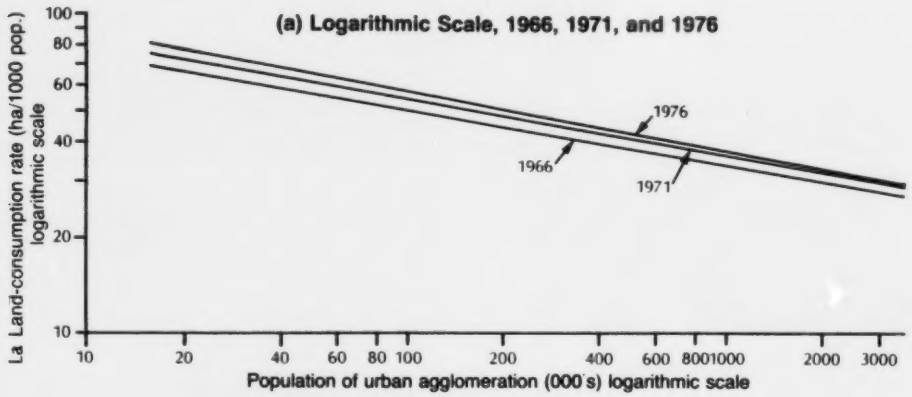
Year	log A	b	t_b	R^2	Mean LCR*
1966	2.5583	-0.1715	-4.56	34.8%	37.16
1971	2.6329	-0.1798	-4.86	37.7%	38.96
1976	2.7681	-0.2008	-6.02	48.8%	39.99

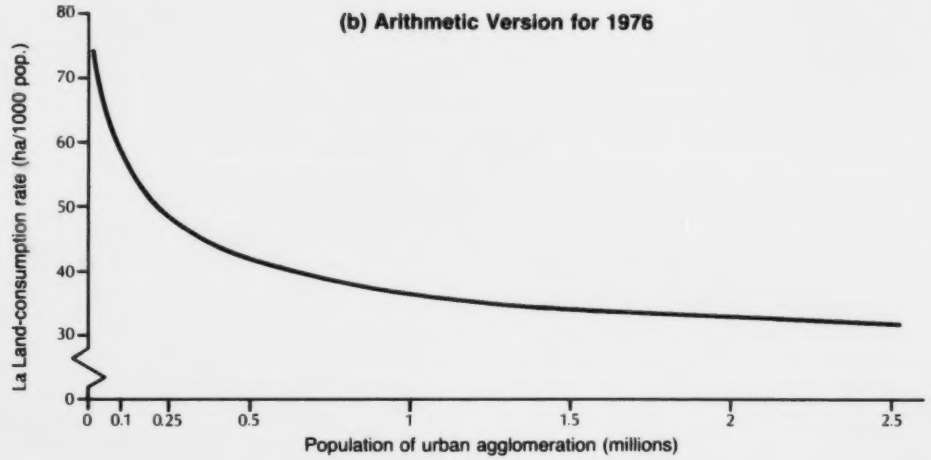
Equation: log(LCR) = Log A – b log (Population size)

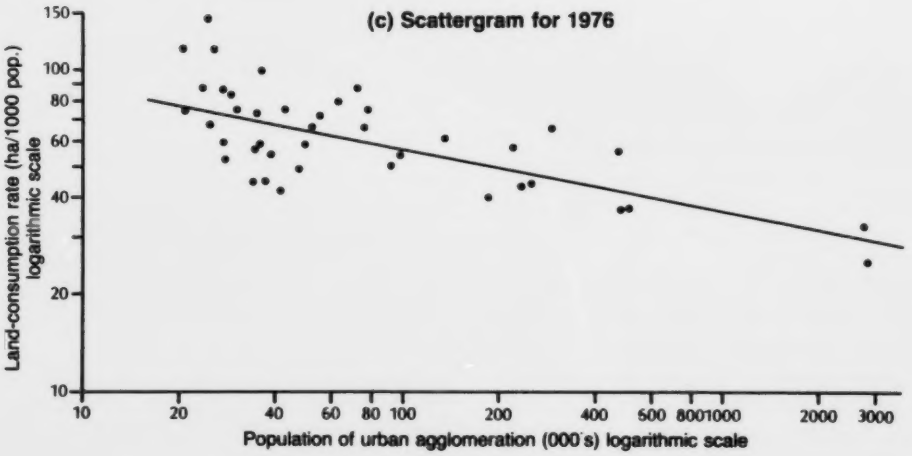
* weighted means calculated from Warren and Rump, 1981.

Figure 2

The Relationship Between Land-Consumption Rates (LCR) and Population Size of Urban Agglomerations







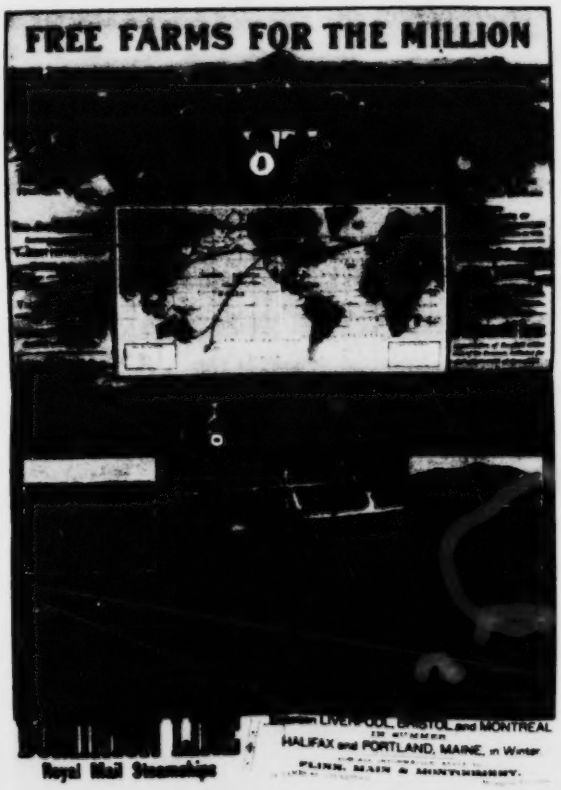
by core/periphery (or heartland/hinterland) and the processes that give rise to such a spatially-structured situation. The literature on this topic is extensive, since unequal development, either within countries or between countries, has been a phenomenon of intense study over the past four decades (Myrdal, 1958; Wallerstein, 1974; Browett, 1984).

The Historical Context

In Canada, as in any other country, unequal development in a core/periphery context is the product of a series of forces and processes that have compounded over time in space (Pred, 1984). A schematic outline, based on that proposed by Ward (1971) for the United States, can identify the various stages of urban growth that have occurred in Canada. The first stage, which is a fairly long period in the country's history, is Canada as a "first periphery" related to the English and French "cores" across the Atlantic. Decisions made in the core generally determine the type of development (economic, political, and social) that occurs in the periphery. Because the core requires the peripheral hinterland for raw materials and a market for some of its manufactured goods, a structure of trade preferences (colonial preferences) and investments is established to create and maintain a peripheral economy dependent upon the production and export of staples (Innis, 1930).

The urban outcome of this type of staple economy is a number of port-cities serving three basic functions: as collecting and export places for the particular staples produced in the region; as wholesaling locations for the repackaging and distribution of imported manufactured goods; and as centres for representatives of core financial institutions. By 1851, the largest cities serving these functions in what was to become Canada were Montréal (80,000), Québec City (45,000), Toronto (30,000), St. John's (30,000), Saint John (24,000), and Halifax (21,000). The total urban population was quite small, perhaps accounting for about 13% of the country's population (Nader, 1975). A basic continuing feature of this urban/rural situation is that entrepreneurial activities emanating from the cities develop the hinterland and continually expand the frontier of economic exploitation (Careless, 1954; 1978).

The economic wealth of cities therefore depends on the production of their immediate hinterlands and on their role as wholesale and distribution centres for manufactured goods. Because leadership in trade and finance is in the hands of a few individuals who can gain a disproportionate share of the wealth generated, a social stratification of society, based on income and ownership of capital, emerges. Furthermore, the wealth accumulated in these urban areas in itself begins to generate economic activity. The emerging élite has a direct interest in maintaining and developing the economic structures that provide the wealth, and seeks to enhance its position by linking the city more extensively with the staple-producing interior through transport improvements. There is a desire to forge stronger links with the hinterland and expand the area served. The city, as a focus of wealth, becomes a market for domestic craft activities and small-scale manufacturing, and the port is involved in shipbuilding and repairs. The urban area begins to grow cumulatively with these various investments, though, in a staple economy, the wealth and size of the city depends on productivity and demand for the staples produced in the interior.



The Public Archives of Canada – C-63482

At the turn of the century, government policy was aimed specifically at discouraging immigration to urban areas to avoid congestion, unemployment, and cultural problems. In fact, only farmers, farm workers, and domestics were encouraged to immigrate to Canada in an effort to accelerate settlement and development of agriculture in the west. This poster, circa 1890, immodestly extolled the unlimited resources and healthy climate of the Prairies.

The "first periphery" situation prevails until the country is able to make major decisions affecting the population within its own borders. At this time, it is possible for a domestic core to emerge (Ward, 1971). The framework for a movement beyond the "first periphery" stage was established through Confederation in 1867, and more

effectively after 1879 with the implementation of various elements of the National Policy. Vital elements of this policy were the construction of a transcontinental railroad system, centred primarily in Montréal and secondarily in Toronto, and the gradual establishment of protective tariffs to nurture domestic manufacturing. This policy of import substitution resulted in higher prices for manufactured goods and was opposed by the staple-producing interior, particularly the inhabitants of the west. An assurance of low freight rates for wheat and other agricultural products produced in the west was consequently enshrined in the national rail-rate structure (the Crow rate) as a political trade-off for protectionism. It is interesting to note that this freight-rate policy has, in turn, reinforced the core/periphery duality within the country.

By the turn of the century, the largest cities, and their relative sizes, were quite different from those prevailing in 1851: Montréal (392,000), Toronto (271,000), Québec (88,000), Ottawa (85,000), Hamilton (83,000), and London (52,500). Rapid urban growth in central Canada resulted not only from the establishment of small-scale manufacturing, particularly in Montréal, Toronto, and Hamilton, but also from the transfer of some administrative and financial functions from the British core to Canada, the emergence of wheat as a major export from southern Ontario and Québec (and later, the Prairies), and a gradual orientation of the Canadian economy away from Britain towards the United States. The first few decades of the twentieth century saw the emergence of two incipient domestic cores, one centred in Montréal (Linteau, *et al.*, 1979) and the other in Toronto (Smith, 1982). In terms of Ward's evolutionary model, however, this era serves as a prelude to the second stage—the emergence of an integrated, industrialized domestic core highly interconnected with a domestic periphery. The information presented in Chapter Three indicates that the second stage of urban growth had, in fact, been attained by 1971.

Core/Periphery Processes

The underlying processes that need to be mentioned are those that could influence the relative growth patterns of the core and the periphery, when industrialization (Simmons, 1979) is occurring along with continued national dependence on the export of raw materials and semi-processed commodities (Watkins, 1977). Three general processes may be identified. The first, convergence, assesses the effects of different wealth and employment-creating opportunities in the core and the periphery. The second, divergence, examines the impact and development of wealth-creating possibilities in the core. The third process focuses on governmental activities, and how legislation and policies contribute to the creation of a core/periphery situation.

The *convergence* approach is rooted in the argument, developed by neoclassical economists (Solow, 1956), that labour migrates in response to inter-regional differences in wage levels, and capital moves in response to regional differences in the rate of return on capital. Therefore, if employment opportunities and the general standard-of-living (i.e., "real wages") are higher in the core region, then labour from the hinterland and from outside the country will migrate to that area. Eventually, the immigration will result in labour surpluses and a reduction in the level of "real" wages to the point where they are equal to or even less than those in the hinterland. The flow to the core will then cease, and population growth in the core and periphery will occur at the same rate.

Likewise, capital, which is necessary for the stimulation of economic growth (Sitwell and Seifried, 1984), also shifts to those activities and regions where the rate of return and security of investments are the greatest. If the rate of return on capital in the core is lower than that in the periphery, money will move to where a greater profit is possible. So, while the core may grow at a greater rate than the periphery for a period of time, there will be a tendency for convergence as capital and people move in response to changing relative wage rates and marginal returns on capital.

The economic *divergence* approach has been articulated most clearly in the circular and cumulative causation model (Pred, 1977). The model suggests that once growth is triggered in an urban area, powerful forces will stimulate additional growth by attracting other economic activities, or by the expanding of existing ones. These forces involve direct and indirect multiplier effects, arising from the economies of agglomeration that are the product of increasing city size. The net result of these forces is cumulative growth that may well continue over a long period of time. A core region could then build continuously upon its initial advantage and increase in wealth at a much faster rate than other areas that did not experience a similar stimulus of industrial activity. Once a core region embarks upon a path of successful industrialization, it develops a self-sustaining advantage over other areas.

Innovation is identified by Friedmann (1973) as a key feature that reinforces self-sustaining growth in the core. In his view, one of the most vital elements of the power of the core is its capacity to create, absorb, and adapt innovations to production (Higgs, 1975). The peripheral area, on the other hand, is a region which, though absorptive of innovations, depends on the core for their creation and adaptation. Innovations diffuse from the core to the periphery, and new developments generate growth and increased productivity. Different economic growth rates between the heartland and hinterland will therefore depend, in part, on the rate of diffusion of

innovations from the core, and the acceptance of these innovations in the periphery.

Governmental actions also help to create a core/periphery situation (Thorburn, 1984; Amin, 1983). The National Policy was obviously conducive to the establishment of manufacturing in and around the leading cities of central Canada, and the dominant position of these cities was ensured by the establishment of a national transport network that was centred in them. With governments, both at the federal and provincial levels, becoming stronger and more pervasive, the number of ways in which they maintain (Simmons, 1983*b*) and reinforce the core/periphery arrangement have increased. For example, the National Energy Program has had a significant impact on urban growth in the west (Sitwell and Seifried, 1984), the Canada-U.S. Auto Pact Agreement has further stimulated manufacturing in the core (Bryan, 1982), and regional development programs have sometimes reinforced growth in the core (Yeates and Lloyd, 1970) and encouraged some limited manufacturing in the periphery.

CONCLUSION

Urban development clearly has a significant impact on the consumption of rural land for non-agricultural purposes. The direct impact, or the amount of rural land consumed for urban land-use purposes, is not only significant, but the land-consumption rate (LCR) is also increasing. However, the indirect impact of urbanization on rural land is difficult to measure. This issue will not be ignored in this study, and measures of the possible indirect impact of urban growth on rural land within the axis will be considered in the concluding chapter.

It is also clear that the factors influencing urban growth in the axis are both complex and interactive. Urban growth must, therefore, be interpreted and projected in light of these general processes. The second chapter identifies the role of the Windsor-Québec City axis in the Canadian economy. Chapter Three provides a more detailed analysis of how the emergence of the core/periphery situation affects urban development. The fourth chapter is concerned with observed trends in some of the processes influencing population and urban growth, and these trends are then incorporated in the final chapter to develop a model for forecasting population growth and urban development to the year 2001. These forecasts are used to estimate the possible impact of future urban growth on the consumption of rural land. The last chapter concludes with a discussion of information gathering and policy questions concerning the general rural/urban conversion issue.

ECONOMIC ACTIVITIES AND LAND

A discussion of the effects of urban development on the consumption of land requires some general knowledge of the geography of the Windsor-Québec City axis. What exactly are some of the major activities within the axis, and where are these located? It is instructive to derive some economic indicators relating to the function of the axis as the core of the Canadian economy, and demonstrate how they differ from indicators in the rest of Canada (the periphery). The changing geographical concentration of some of these economic characteristics should also be documented. This information will provide the context for a discussion of urban growth and land consumption in later chapters.

THE ROLE OF THE AXIS AS THE CORE

The role of the axis as the core of the Canadian economy can be illustrated in two ways. First, particular indicators comparing the axis with the rest of Canada are developed and used to demonstrate recent changes in the economic importance of the axis. Second, measures are related to the differing patterns and structure of international trade emanating from the provinces that contain the core and the hinterland. The first group of indicators are static descriptors of the core and periphery, while the second set relate to flows derived from the two different areas.

Core/Periphery Indicators

While there have been some fluctuations in the indicators listed in Table 3 since 1961, the information emphasizes the continuing vital role of the Windsor-Québec City axis in Canada. Over 54% of the population of the country is located in the axis, which constitutes an estimated 14% of the "occupied" area of the country. This high concentration of population in one large macro-urban region is similar in magnitude to that experienced in some other countries, though the scale is different, because Canada is extremely large in area with a small population for its size. For example, the Tokaido "megalopolis" of Japan, as defined by Ito and Nagashima (1980), contains almost 54% of the population of that country; and the traditional manufacturing "heartland" region of the United States, consisting of Gottman's (1961) "megalopolis" and Leman and Leman's (1976) "Great Lakes megalopolis", contains 41% of the American population. This core population was also, on average, 10% wealthier than in the periphery in 1961 and 1970, but in 1981 the average income level was about the same.

A major distinguishing feature of the axis is clearly its dominance in manufacturing, which remains undiminished. Seven out of every 10 manufacturing jobs are located within the axis, and this activity generates a concomitant share of the value created in the process. In contrast, the axis plays no special role in service employment which, as might be expected, is distributed roughly in accordance with the population share. Service employment, however, has increased substantially over the past few years, and in 1981 these tertiary activities occupied more than 63% of the national labour force.

Farm cash receipts, and hectares in farmland, provide indicators of the relative importance of staples in the economy of the periphery compared with that of the core. Only 12% of the nation's area in farmland is located in the core, and this proportion has been rapidly declining in recent years. However, this limited amount of farmland produces over one-third of the total cash receipts received by the nation's farmers. Agricultural activities in the axis are generally intensive in nature, involving high-revenue activities per hectare (Bryant and Russwurm, 1981). Smaller farms and intensive agricultural production mean that farm employment in the axis is relatively high compared with the non-axis portion of the country. In fact, about 45% of the country's labour force employed in primary activities (agriculture, fishing, forestry, and mining) resides in the axis.

One trend of particular interest relating to the impact of urban development is the loss of farmland in the axis. In the 15-year period between 1966 and 1981, almost two million hectares, equivalent to more than 11% of the total area of the axis, disappeared from farming. Much of the loss occurred as a result of farm abandonment in areas of poor soils and low productivity (McCuaig and Manning, 1982), but a considerable amount has also been absorbed either directly or indirectly through urban growth and expansion. In particular, the rate of farmland loss in the axis has been considerably greater than in the rest of the country. A fundamental issue being addressed in this study is the amount and quality of the two million hectares that have been lost as a result of the direct and indirect effects of urban development.

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Table 3

Some Indicators of the Changing Role of the Windsor-Québec City Axis in Canada, 1961-1981

Indicators	Axis	Rest of Canada	% in Axis
Area (000s of km²)			
Total area	175	9,799	1.8
Occupied area[1]	175	1,099	14.0
Population			
1961 (000s)	9,745	8,583	53.2
1971	11,920	9,648	55.3
1981	13,194	11,154	54.2
Total National Income[2]			
1961	12,813	8,666	59.7
1970	30,946	19,873	60.9
1981	125,967	108,027	53.8
Manufacturing Employment[3]			
1961 (000s)	986	366	72.9
1971	1,173	464	71.7
1980	1,355	495	73.2
Value Added[3]			
1961 ($ millions)	8,129	2,803	73.4
1971	16,132	5,286	75.6
1980	50,486	19,409	72.2
Farm Cash Receipts[4]			
1966 ($ millions)	1,533	2,741	35.9
1971	1,747	2,766	38.7
1981	6,356	12,325	34.0
Hectares in Farmland[5]			
1966 (000s)	10,023	60,444	14.2
1971	8,950	59,714	13.0
1981	8,075	57,815	12.0
Tertiary Employment[6]			
1971 (000s)	2,821	2,159	56.6
1981	4,393	3,407	56.3

Notes: 1 The estimate of "occupied" area of Canada is taken from L.D. McCann, 1982, 8.
2 Estimates based on total income from taxable and non-taxable returns in *Taxation Statistics*, 1963, 1972, and 1983, for census divisions. Estimates for partial census divisions are prorated according to population share.
3 Statistics Canada, *Manufacturing Industries, Series G*, 1964 and 1973; Statistics Canada, *Manufacturing Industries of Canada: Sub-Provincial Areas, 1980*, prorated.
4 Statistics Canada, *Farm Cash Receipts*, 27, 4; 32, 4; and 43, 12. Estimates for partial census divisions based on proration related to farm area.
5 Statistics Canada, *Number and Area of Census Farms*, 1971 and 1981.
6 Statistics Canada, *Labour Force, 15 years and Over, by Industry Type, by Census Subdivision, by Residence, 1981*, Microfiche CTE 81B35, and a special tabulation for 1971 (6591-P01826-213-1971). The tertiary employment category includes the labour force in: transportation and communications; trade, wholesale and retail; finance, insurance, and real estate; community, business, and personal services; and public administration and defense.

Core/Periphery External Trade Patterns

The external trade patterns of the core and periphery should reflect the different characteristics of the economies of the two components defined in Table 3. Unfortunately, external trade information cannot be obtained for parts of provinces and individual metropolises, so the core will have to be regarded here as Ontario and Québec, while the rest of Canada is defined as the periphery. The primary commodity-producing areas of northern Ontario and Québec, involving mainly mining and partial refining (Sudbury, Chicoutimi-Jonquière, Rouyn-Noranda), forestry, and hydro-electric power, are consequently included in the "core". Data for the "core"

will therefore be weighted more to primary production than is actually the case.

Table 4

Canada: Imports and Exports by Commodity Grouping, 1982

Commodity Group	Imports (%)	Exports (%)
Live Animals	.2	.5
Crude Materials, Inedible	12.9	18.1
Food, Feed, Beverages, Tobacco	7.1	12.1
Fabricated Materials, Inedible	17.5	34.2
End Products, Inedible	60.8	34.8
Special Transactions	1.5	.3
Total Volume ($000s)	67,355,341	81,463,975

Sources: Statistics Canada, Feb. 1983, *Summary of External Trade, Dec. 1982*, Cat. No. 65-001, and Ontario Ministry of Industry and Trade, Nov. 1983, *Ontario Exports and Imports, 1982*.

Although 1982 was an unfortunate year for the world economy, the trade data do reflect basic core/periphery contrasts. The favourable balance of trade (exports exceed imports) is misleading (*see* Table 4), because the balance of payments, which includes financial transfers for loans, interest payments, insurance fees, dividends, and capital investments, and so forth, is negative. However, the trade data demonstrate that Canada generally imports manufactured end products, partially-fabricated materials, crude materials, and food products. The staple nature of the economy is apparent, though there is considerable trade (by value) in end products.

Figure 3 reveals the differences between the core and periphery. The periphery dominates the export trade (79%) in crude materials (particularly oil, forest products, and natural gas), most of which go to the United States. Crude materials are often partially fabricated in the core, and then exported primarily to the United States. On the other hand, food products, which include wheat, grains, flour, and processed food and feed, involve both the core and the periphery and are exported all over the world. Fabricated materials, such as steel, copper wire, refined nickel and rolled aluminum, are produced mainly in the core and exported primarily to the United States, but a considerable amount also goes elsewhere. Finally, manufactured end products are produced virtually only in the core and are exported to the United States. Canada exports staple commodities and manufactured products, and, as the level of processing and manufacturing increases among the commodity groups, the core becomes more dominant in this trade. The United States is the chief recipient of all exports except food products.

This overwhelming link with the economy of the United States, and the role that the core plays in this link, is also apparent with respect to imports. As a staple-producing country, Canada's imports of food products and crude materials are fairly small in comparison with fabricated materials and end products. Imports are mainly of sub-tropical and fresh food and fruits and crude oil (to eastern Canada). The greatest value of imports by far involves end products from the United States, and a large part of this trade is in motor vehicles and parts.

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Only 0.5% of Canada's land area is CLI Class 1 soil, which has no significant limitations for agriculture and has the highest productivity for a wide range of crops. Over 50% of Canada's Class 1 farmland is in southern Ontario. It has been estimated that from the top of the CN Tower it is possible to see 37% of the country's Class 1 agricultural land.

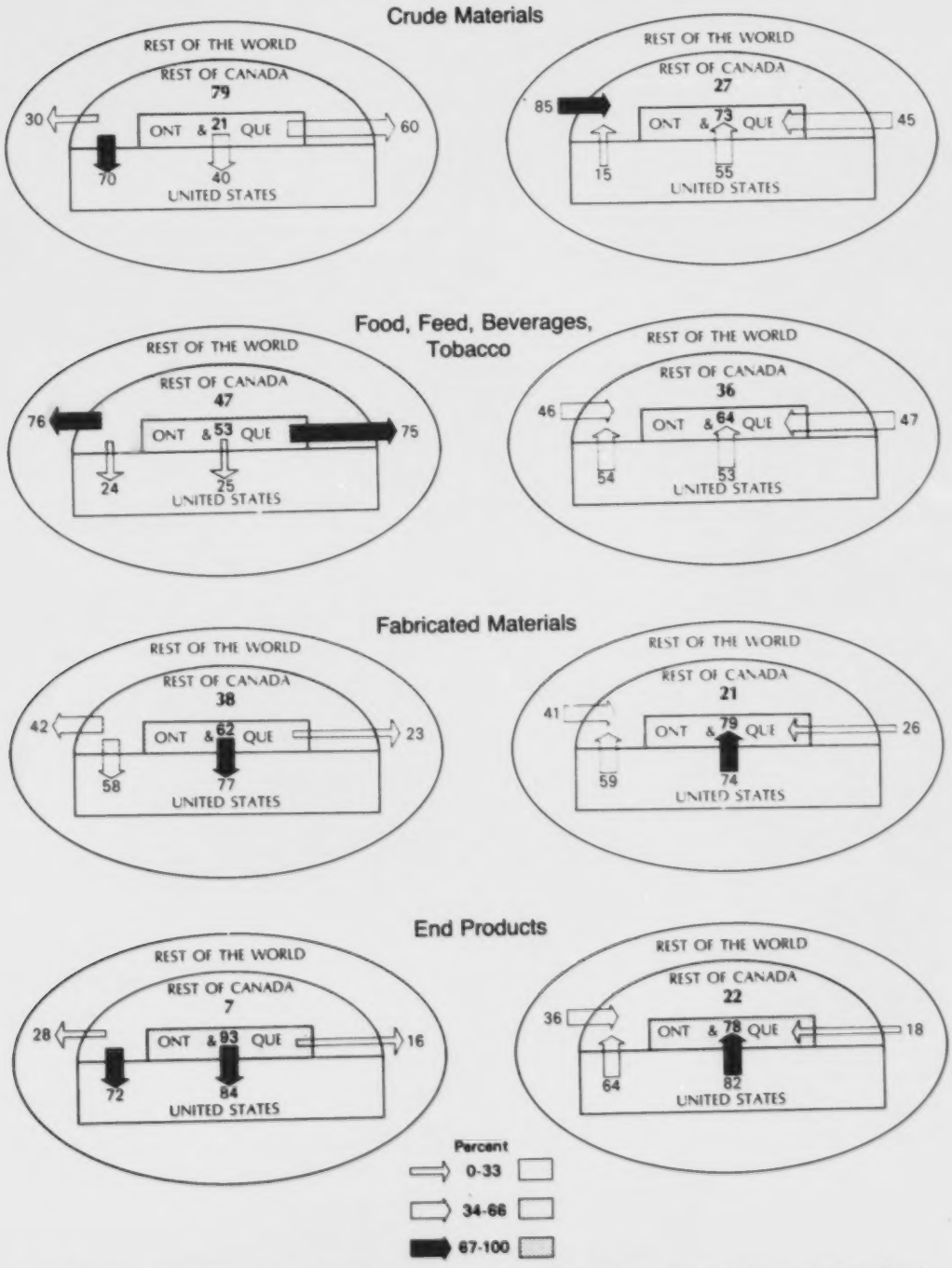
Much of the export of end products from Canada to the United States, and import of end products from the United States to Canada, involves the auto industry, because the 1965 Canada-U.S. Automotive Trade Products Agreement (Auto Pact) has rationalized the North American auto industry and there is a considerable flow of these high-value products across the border (Holmes, 1983). End-product imports from the United States also include a wide variety of other manufactured products.

Figure 3

Cartogram of Exports and Imports, 1982

(a)
Exports from the Core/Periphery to the US and the World

(b)
Imports from the US and the World to Canada



Sources: Statistics Canada,Summary of External Trade, Dec. 1982, (Feb. 1983), and Ontario Ministry of Industry and Trade, Ontario Exports and Imports, 1982, (Nov. 1983).

Thus, the core/periphery arrangement in the Canadian economy is apparent in the general pattern of international trade. Staples and food products form a large share of exports, and the periphery is the source of most of these products. The core dominates both the export and import of fabricated products. The ties to one trading partner, the United States, are exceptionally strong, vividly identifying how the Canadian economy depends upon that of its nearest neighbour.

THE PHYSICAL ENVIRONMENT OF THE CORE

The cartographic artifact defined as the Windsor-Québec City axis coincides with, but is not restricted to, four major physiographic regions. The first of these, *Interlake Ontario*, is basically the remnant of an old sea floor sculpted by glacial erosion and refashioned with glacial deposits (*see* Map 2). Some of these deposits yield good soils along with little relief, such as in southwestern Ontario, but in other areas the surface debris is rather thin and sandy, or full of drumlins, yielding poorer farmland. One notable feature in Interlake Ontario is the Niagara Scarp, extending in a sinuous fashion from the Bruce Peninsula, along the southern shore of Georgian Bay (with downhill ski resorts), and south to the Niagara Peninsula. This resistant outcrop, with its steep easterly (and northerly) facing scarp, and shallow slope dipping gradually to the west, provides spectacular scenery, particularly where it is cut by the Niagara River to form Niagara Falls.

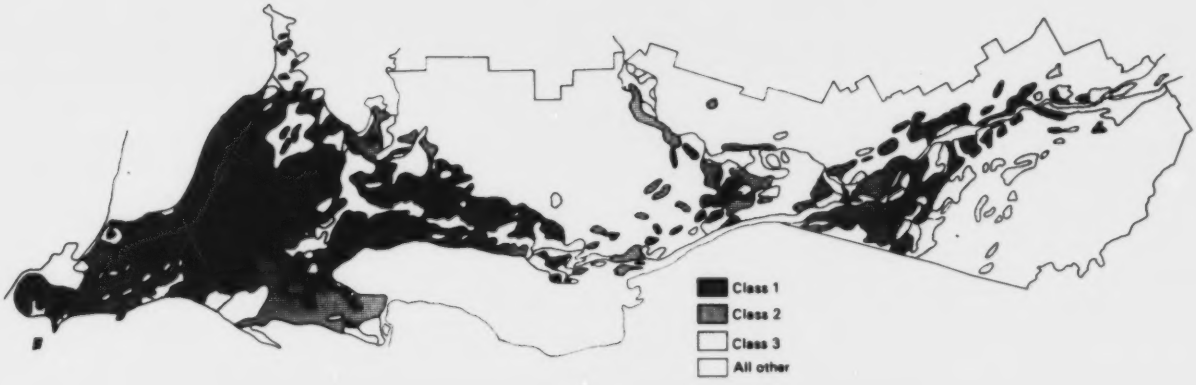
The small portion of the *Canadian Shield* that is located within the axis has the appearance of a much dissected plateau, varying in height from 1 000 metres at Mont-Tremblant to a few hundred metres in eastern Ontario. Its joints, fault lines, and bands of weaker rock have been eroded by water and ice over the ages to form valleys and gorges. The occasional deposits of clay are useful for farming, but they are rarely extensive enough to provide a basis for profitable agriculture, because the rock throughout most of the area has been scraped bare by abrasive glacial action. Consequently, the area of the Shield within the axis is economically inimical to settlement. The only exceptions are the occasional mining, lumbering, and pulp and paper towns, which depend on the exploitation of natural resources, and the recreational centres, such as the skiing resorts in the Laurentians and the vacation resorts located in the Thousand Islands region.

The prong of the Shield that leads to the formation of the Thousand Islands separates Interlake Ontario from the third region, the *St. Lawrence Lowland*. The two lowland areas are similar in appearance, since both have been subjected to continental glaciation, though the incursion of an arm of the Atlantic during part of this period affected this area more than Interlake Ontario and created some differences. Broad areas of clay are interspersed with pockets of sandy deposits, such as those found on the broad flat Montréal plain. This agriculturally important plain is relieved of its monotony by 11 hills, three of which are outliers of the Canadian

Map 2

Major Physiographic Regions Within the Axis

Map 3
Soil Capability for Agriculture



Compiled and generalized from: Lands Directorate, Environment Canada, Soil Capability for Agriculture: Québec and Ontario, 1:1,000,000.

Shield. The remaining eight hills are of harder volcanic rock and have remained as hills following the erosion of the softer surrounding material. Some of these hills have become important for settlement purposes and are the sites of parks (i.e., Mount Royal) as well as private estates; today, many housing subdivisions are being located on their lower slopes.

The fourth physiographic region, found in the Eastern Townships of Québec, consists of part of the extensive *Appalachian* mountain system of the United States. In this northerly extension, the mountains are not very high, most peaks being between 600 and 1 200 metres above sea level. Because the surface has been eroded and disrupted through many ages of continuous abrasive and geologic action, all that remains is the rounded cores of the mountains with a drainage pattern that has frequently been imposed upon them. Most of the upland areas are covered with forests or rough scrub, and settlements are located in the river valleys. There are some mining towns (e.g., Asbestos), but the area is generally inimical to settlement because farming is uneconomic and transportation is difficult.

Given the discussion of regional physiography, climatic conditions are best summarized with respect to the two lowland areas, since the Shield and rounded Appalachian areas are not as favourable for human habitation. Although the entire axis is located in a "humid continental, short summer" climatic zone, the most favourable climatic conditions for agriculture (and settlement) prevail in the southwestern portion of Interlake Ontario. The warmest summer climate, greatest heat accumulation, and shortest winters are in Essex County around Windsor, the Niagara Peninsula, and along the coastal margins of Lakes Erie and Ontario. The Ottawa Valley and St. Lawrence Lowland areas have longer and colder winters, and shorter and cooler summers, than southwestern Ontario. Climatic conditions for agriculture are definitely much better in southwestern Ontario, but the somewhat shorter and cooler summers in Québec also provide a good environment for certain types of agriculture.

These physiographic and climatic variations combine to produce some noticeable differences in the capability of soils for agriculture in the axis. Map 3 presents the following classes of soil capability for agriculture:

Class 1:	soils that have no significant limitations for crops;
Class 2:	soils with moderate limitations that restrict the range of crops or require special conservation practices;
Class 3:	soils with moderately severe limitations that restrict the range of crops or require special conservation practices;
Other:	soils with at least severe limitations that restrict the range of crops, and/or require special conservation practices, and frequently cannot be improved.

There is virtually no Class 1 land available in the St. Lawrence Lowland area, though there is an extensive area of Class 2 land south of Montréal. The most extensive available area of Class 1 land is in the Interlake Ontario region, which contains more than half (54%) of all Class 1 land in the country (McCuaig and Manning, 1982). Since this definition of land capability for agriculture is somewhat restricted, Map 3 distinguishes the three classes most suited to agriculture from "all other" classes which are generally not well suited. Even with this more generous distinction of soils that are good for agriculture from those that are not well suited, the axis provides 21% of Canada's best land for agriculture (Classes 1, 2, and 3).

POPULATION AND LANGUAGE

Map 4 demonstrates the concentration of the population of the axis into major metropolitan areas, based on the 1981 populations of the Census Metropolitan Areas (CMAs) and the larger urban agglomerations. These cities contain about 73% of the population of the axis (*see* Table 5), and between 1971 and 1981 they grew less than the decadel increase in the axis population as a whole (10.6%). Three features of the map need to be emphasized: (1) the clear dominance, in terms of size, of the CMAs of Toronto and Montréal, each containing about three million people; (2) the greater number of metropolitan areas located in south and western Ontario compared with southern Québec; and (3) the wide variation in growth rates, with Toronto and nearby urban areas, and the administrative centres of Ottawa-Hull and Québec City, having rates of increase above that for the axis as a whole. One CMA, Windsor, actually experienced a population decrease in the 10-year period.

These distinctive urban size and growth rate characteristics are even more interesting when examined in the context of the language and culture of the populations involved. The axis contains parts of the two provinces in which the two groups of people who first settled the nation are concentrated. The language maps (*see* Map 5) are based on a 1981 census question concerning the language first learned in childhood and still understood (comparable with the "mother tongue" question posed in previous censuses). Together, the French and English language groups comprise 86.5% of the population of the axis. The next largest group, Italian, involves only 3.5% of the population, though a much greater proportion responded as being in the Italian ethnic group. The descendants of many other ethnic groups often now first learn English or French.

Given the preponderance of the two major language groups, it is important to note that they are located distinctly in the two provincial portions of the axis. Nearly 80% of the population in the Québec portion of the axis is French speaking, and the proportion drops below 80% in only two parts of the province, along the Ontario and U.S. borders and on the Île de Montréal (*see* Map 5*a*). A small part of Ontario, along the Québec border around Hawkesbury, is also predominantly French speaking. The location of the English-speaking population is virtually a mirror image of the French (*see* Map 5*b*). Almost the entire portion of Ontario located in the

Map 4

Concentration of Population in Metropolitan Areas, 1981

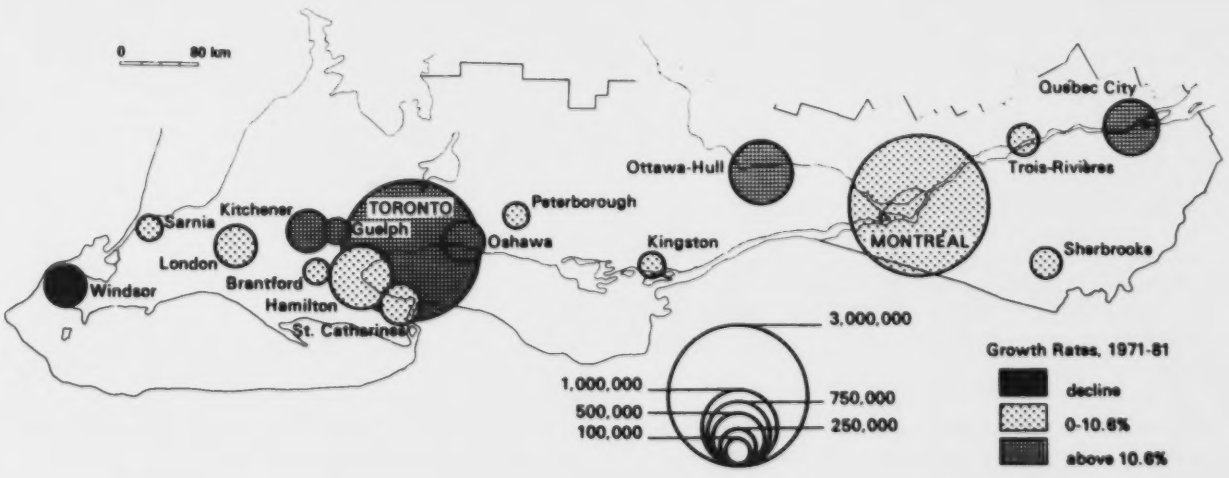


Table 5

Population of Census Metropolitan Areas (CMAs) and Large Census Agglomerations (CAs), 1971-1981*

Urban Area	1971	1981	% Change
Toronto	2,605,253	2,998,947	15.11
Montréal	2,715,428	2,828,349	4.16
Ottawa-Hull	619,845	717,978	15.83
Québec City	500,714	576,075	15.05
Hamilton	503,154	542,095	7.73
St. Catharines-Niagara	285,800	304,353	6.49
Kitchener-Waterloo	238,570	287,801	20.64
London	253,910	283,668	11.72
Windsor	248,715	246,110	– 1.05
Oshawa-Whitby	120,320	154,217	28.17
Sherbrooke	106,244	117,324	10.43
Kingston	105,915	114,982	8.56
Trois-Rivières	103,703	111,453	7.47
Brantford	80,285	88,330	10.02
Peterborough	79,160	84,701	8.26
Sarnia	78,411	83,951	7.07
Guelph	66,386	78,456	18.18
Total	8,711,813	9,619,790	10.42

* 1981 boundaries used for both dates.

axis is English speaking, with the only exceptions being along the Québec border. Of particular note is the English-language concentration in the western part of Île de Montréal.

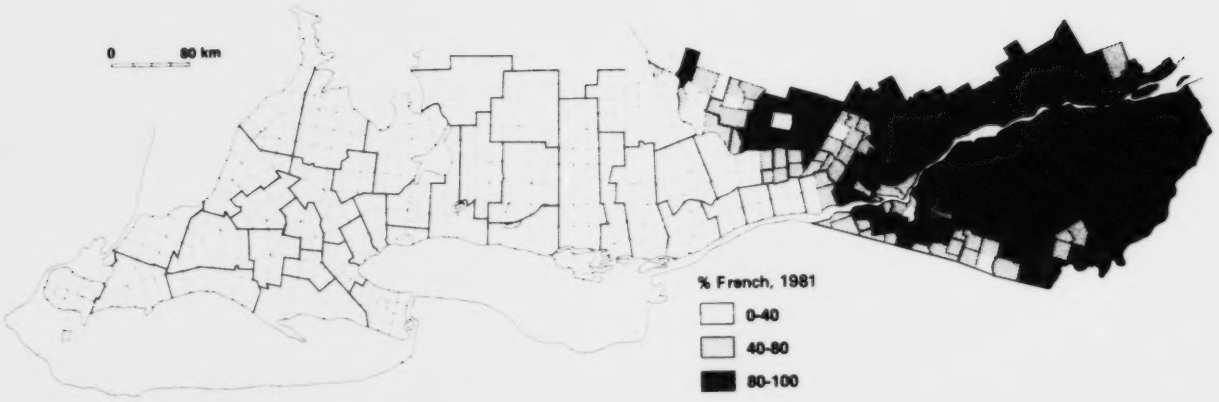
The Italian-speaking population has been included because it forms the largest of the minority language groups, is the product of a recent period of immigration (1951-71), and is highly localized in the major metropolises of Toronto and Montréal (*see* Map 5c). The number of Italian-speaking people, along with people from other southern European countries, is now of sufficient magnitude in certain locations to have become a new political force in both provinces.

Map 5

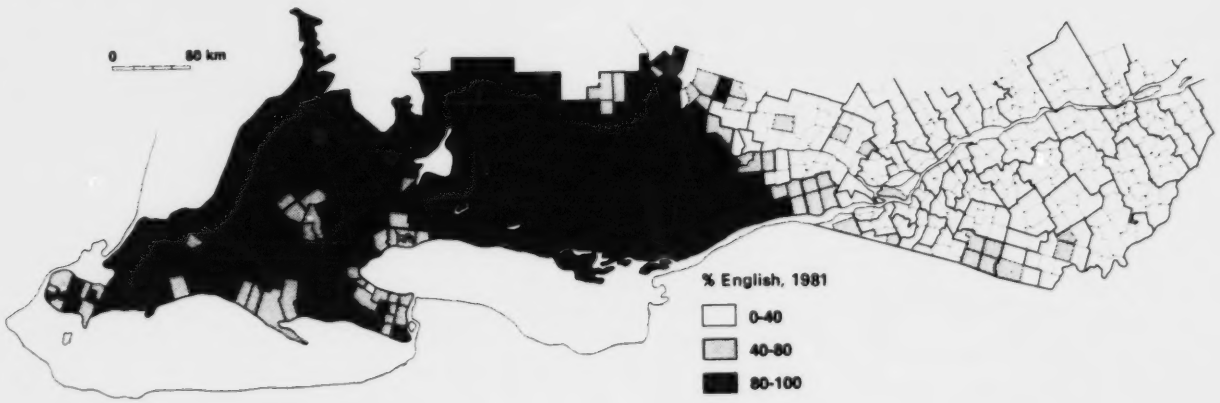
Proportion of Population of Language Groups in Census Subdivisions, 1981

(language first learned and understood)

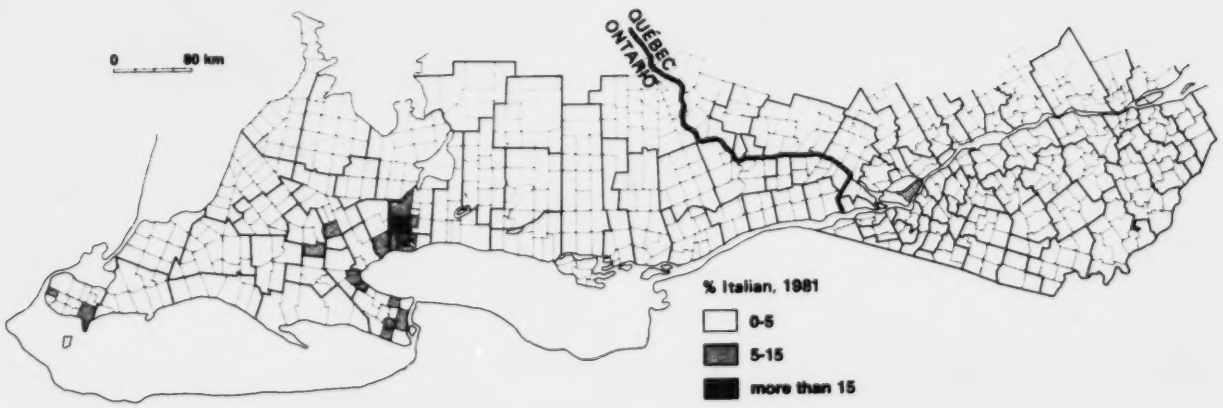
(a) French



(b) English



(c) Italian



The change in language first learned is interesting given the pressure for linguistic hegemony in Québec over the past years (*see* Table 6). Although the data are not strictly comparable ("mother tongue" in 1961 and 1971 is not exactly the same as "language first learned" in 1981), the trends appear to be reasonably consistent. The proportion of the French-speaking axis population located in Québec has increased steadily, from 78% in 1961 to almost 80% in 1981, and the proportion that was originally English speaking has declined from 15.3% in 1961 to 12.4% in 1981. In Ontario, the originally English-speaking proportion has declined slightly, presumably as a result of recent immigration from non-English-speaking countries, and the French-speaking proportion is quite small and becoming smaller. There is, therefore, an increase in the level of polarization, with axis-Québec becoming more French and axis-Ontario even less French. Italian and other ethnic groups have not been tabulated, because it is clear that second-generation families on the whole adopt either English or French as the language first learned.

AGRICULTURAL DIVERSITY

It was noted above that, whereas the axis has only 12% of the farmland in the country, it has more than one-fifth of the better land (Classes 1, 2, and 3), and the farms in the axis generate more than one-third of the cash receipts received by Canada's farmers. Axis farmers, because of proximity to urban markets (Bryant, *et al.*, 1984), good land, and high land prices (Manning, *et al.*, 1979), concentrate on outputs that yield high revenues per hectare. The axis has:

- 91% of all the land devoted to tender fruit and tobacco;
- 76% of the land in vegetables, nursery products, greenhouses, etc.;
- 63% of all dairy cattle;
- 61% of the land in apples and pears;
- 57% of all hens, chickens, turkeys, ducks, and geese;
- 42% of the beef cattle, pigs, horses, etc.;
- 37% of all sheep;
- 29% of the land in potatoes, sugar beets, beans, peas, etc.; and
- 15% of the land in grains (principally corn, wheat, and oats).

While this list may be more appropriately used as a country lyric, it highlights the concentration of production in perishable and expensive agricultural commodities. The production of grains, however, is extensive, and consumes nearly 60% of the land in farmland within the area, and much of the rest of the land is devoted to pasture or the production of hay.

Map 6 illustrates the chief locations (by county) for the main types of agricultural output in the axis. Each map shows areas of concentration in production for two groups of commodities (for example, tender fruits and apples), so there is some overlap in counties concentrating in both commodities. The map shows those

Table 6

Changes in Language First Learned, 1961 to 1981

Group	1961		1971		1981	
	Ontario	Québec	Ontario	Québec	Ontario	Québec
English						
number (000s)	4,383	651	5,449	745	6,114	670
percentage	80.0	15.3	79.1	14.8	78.4	12.4
French						
number (000s)	263	3,320	309	3,940	313	4,312
percentage	4.8	78.0	4.5	78.3	4.0	79.9

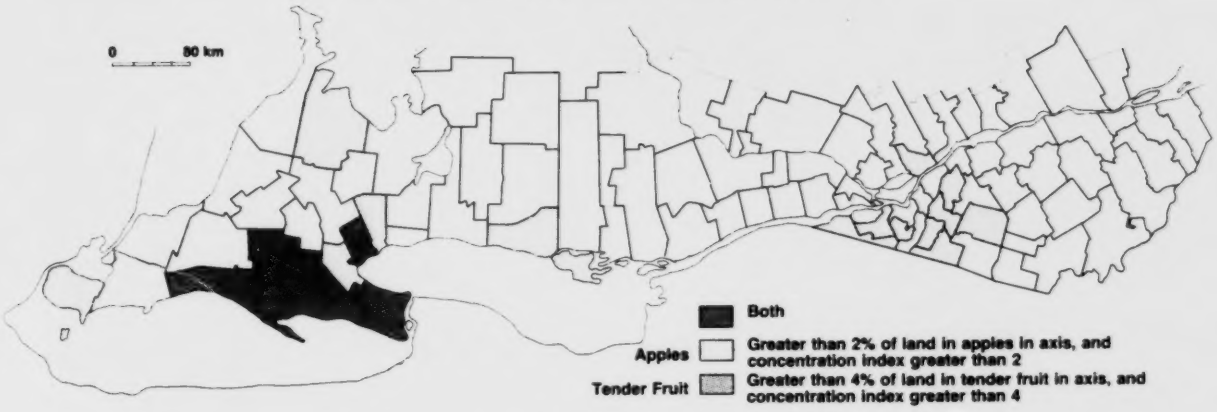
Note: Percentages are of the total axis population for Ontario and Québec.

Sources: Statistics Canada, 1982, *Census Divisions and Subdivisions: Selected Characteristics, Québec E-563*, Cat. No. 93-X-917 and *Ontario E-564*, Cat. No. 93-X-918.

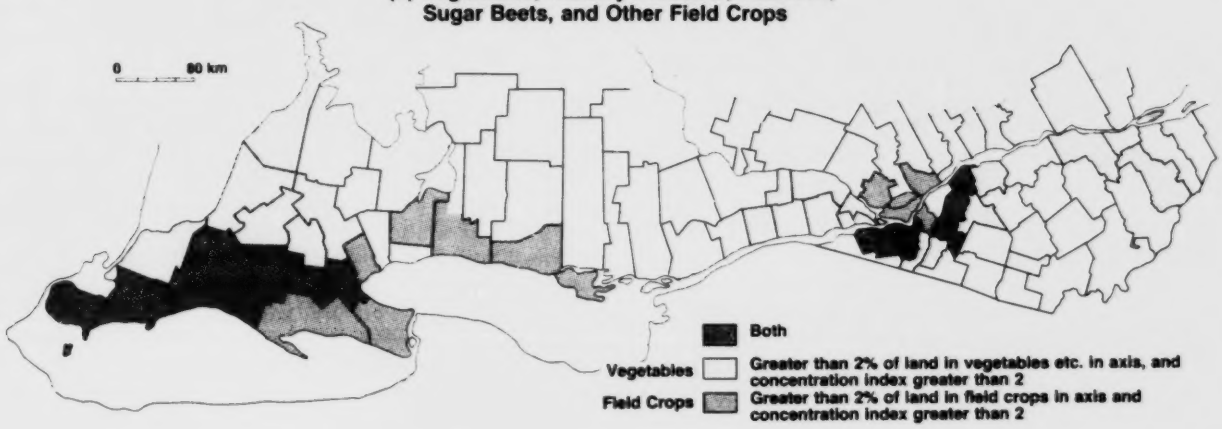
Map 6

The Location of Agricultural Production, by Census Division, 1981

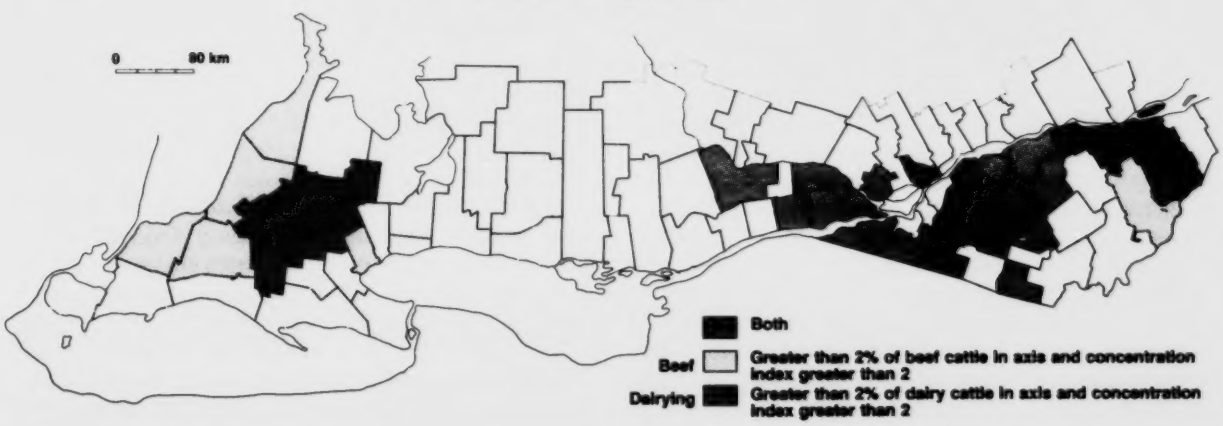
(a) Tender Fruits (and Tobacco) and Apple Orchards


0 80 km
Both
Apples
Greater than 2% of land in apples in axis, and concentration index greater than 2
Tender Fruit
Greater than 4% of land in tender fruit in axis, and concentration index greater than 4

(b) Vegetables, Nursery Products, Potatoes, Sugar Beets, and Other Field Crops


0 80 km
Both
Vegetables
Greater than 2% of land in vegetables etc. in axis, and concentration index greater than 2
Field Crops
Greater than 2% of land in field crops in axis and concentration index greater than 2

(c) Beef and Dairy Cattle


0 80 km
Both
Beef
Greater than 2% of beef cattle in axis and concentration index greater than 2
Dairying
Greater than 2% of dairy cattle in axis and concentration index greater than 2

Edward W. Manning

The Niagara fruitbelt is superior to any other orchard area in Canada and produces a major share of the nation's peaches, grapes, sweet and sour cherries, pears, plums, apples, and small fruits. Urbanization here is the most significant factor in the decline of this unique land resource. In the St. Catharines-Niagara-Fort Erie urban-centred region, 84% of all rural land converted to urban use between 1966 and 1981 was prime farmland (CLI Classes 1-3).

counties where the volume and concentration of production are high in comparison with the other counties in the axis. If the apples map is taken as an example, a census division containing more than 2% of the axis land in apples is considered to play a significant role in apple production in the area. The county will not be shaded, however, unless the proportion of land devoted to apples in the county is more than twice the proportion of apple land in the axis. The first criterion is biased in favour of size, or the amount of land involved, whereas the second takes into account concentration and is size independent.

A quick perusal of the three combined maps in Map 6 demonstrates the controlling influence of regional physiography (*see* Map 2; Parson, 1984) and soil capability for agriculture (*see* Map 3). The tender fruit and tobacco lands (*see* Map 6*a*) are clearly located on the good and well-drained soils and in the most equable climatic area, between Lake Erie and Lake Ontario in southern Ontario. Given the particular soil and climatic requirements of the crops in this group, there is little possibility of these commodities being produced anywhere else in the axis or Canada (Krueger, 1982). Apple orchards are concentrated in the same areas as tender fruit, and also on other south-facing slopes around Lake Ontario (Prince Edward County), between Lake Erie and St. Clair, and in the southernmost townships of Québec.

The map combining vegetables and nursery products and field crops (potatoes, sugar beets, peas, beans) illustrates the impact of local demand, soils, and climate on commodity location (*see* Map 6*b*). The large urban concentrations in the axis provide a big market for crops of these types, so production is concentrated around Montréal and Toronto, and through southwestern Ontario in a broad belt to Essex County (Neimanis and McKechnie, 1980) and Windsor.

The large population in local urban markets also accounts for the location and heavy concentration of dairying in the axis. Over the past 30 years, there has been a considerable restructuring of the Canadian dairy industry (Sundstrum, 1984), with the number of dairy farms and operators decreasing substantially and the size of farms and herds increasing. Production has shifted towards fluid milk (away from cream and industrial milk) for the rapidly growing urban markets, especially in Québec (Smith, 1984) where the dairy industry is particularly important. In the area defined by the St. Lawrence Lowland and river valleys of Beauce, there has been an expansion of large agri-business type

Table 7

Change in Amount of Land in Various Agricultural Uses, 1971-1981 (ha)

Types of Commodities	1971	1981	% Change
Apple Orchards	22,806	20,882	– 8.4
Tender Fruit and Tobacco	51,280	60,600	18.2
Vegetables and Truck Farms	85,719	98,797	15.3
Field Crops (potatoes, peas, etc.)	91,707	128,748	40.4

Source: Statistics Canada, *Census of Agriculture*, 1971 and 1981.

farms, and the emergence of a number of independent operators producing milk on a contract basis. On the other hand, there has been a significant decline in the number of smaller, independent, non-contract, diverse family farms. In conjunction with corn and oats (Joseph and Keddie, 1981) and dairying, there are also extensive areas where beef cattle and pigs are being prepared for urban markets.

Physical factors and the distribution of urban markets, therefore, influence considerably the presence and location of particular types of agriculture within the axis. With respect to the particular types of agriculture in which the axis specializes, the demand for their products is increasing and the amount of land directed to their use is also increasing (*see* Table 7). Furthermore, since the number of dairy cattle has doubled and beef cattle have tripled in the same 1971-1981 period, then the farmland devoted to these purposes must have increased as well. However, the total amount of farmland has actually decreased in the same period, so the land used for these purposes must have come from land previously in grains and pasture. The axis is experiencing a slow and inexorable shift to agricultural output with a high value per hectare, and this is occurring at the expense of land in grains and pasture. At the other end of the land spectrum, urban uses are also threatening agricultural land through direct transfers and indirectly through escalating land prices and environmental impacts.

THE AXIS AS THE MANUFACTURING HEARTLAND

Although there is some manufacturing employment in a large number of towns and cities within the axis (Marshall, 1981), the bulk of the employment is in major metropolitan areas large enough to generate local industrial complexes (Norcliffe and Ekotseff, 1980). Sixteen cities have a manufacturing labour force of more than 10,000 people, and between them they account for 73% of the 1981 total labour force in manufacturing in the axis. The CMAs of Toronto and Montréal contain almost one-half of the axis total, while the other metropolitan areas contain small proportions. Hamilton has about 6% of all axis jobs in manufacturing; Kitchener-Waterloo 3.5%; St. Catharines-Niagara, Windsor, London, Québec City, Oshawa-Whitby, and Ottawa-Hull between 2% and 3% each; Brantford, Guelph, Peterborough, Sarnia, Sherbrooke, and Trois-Rivières about 1%.

The information in Table 8 is based on labour force estimates (15 years and over) from the 1971 and 1981 Census and differs from that used for manufacturing in Table 3. The manufacturing and value-added data in Table 3 are based on returns submitted annually by manufacturing plants and record actual employment at the time when the questionnaire was completed. The information in Table 8 is derived from a question in the longer version of the decennial census of households about the kind of business, industry, or service an individual has worked for longest in the previous 17 months. The total manufacturing labour force information used in Table 8 is therefore higher (1.61 million for the axis in 1981) than the total in Table 3. The advantage of this information is that a tabulation can be obtained by residence (that is, where an individual begins to disburse a pay cheque) rather than by location of plant.

Given that the axis is the manufacturing heartland of Canada, it is not surprising that all types of industry are

represented in the area (*see* Table 8). Particularly representative of the "heartland" role is that the most predominant manufacturing activities in the area involve a high level of processing and a number of fabrication stages, for example, the "needle" trades, machinery and transport equipment manufacturing, metal fabricating, and the chemical industry. The industries least well represented are those based directly on raw material production—wood processing and paper manufacturing.

Table 8

Distribution and Relative Concentration of Employment in the Major Manufacturing Groups Within the Axis, 1981, and Percentage Change in Labour Force, 1971-1981

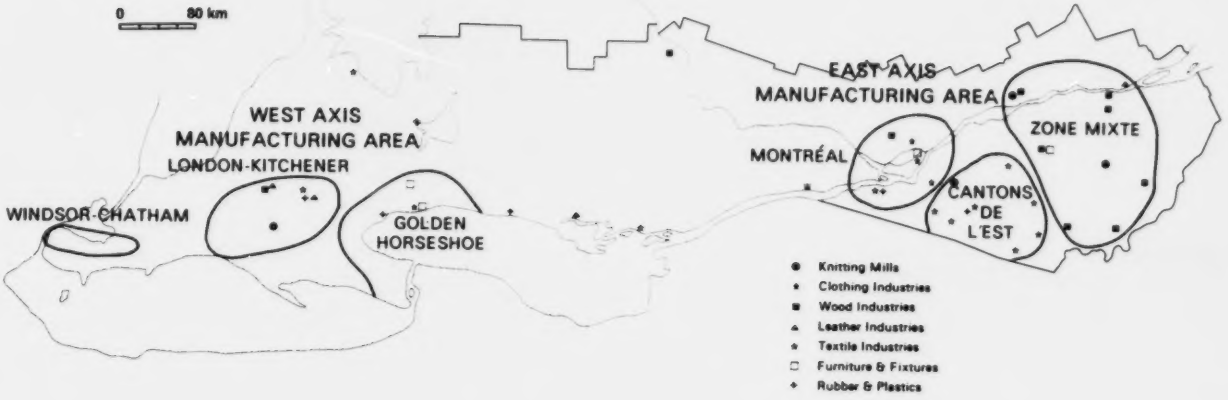
Major Group	% of Axis Manufacturing Labour Force	% of Canada's Labour Force in Axis	1971-1981 % Change
Food and Beverages	10.4	53.9	18.4
Tobacco Products	0.5	94.4	- 8.3
Rubber and Plastics	3.7	83.8	41.0
Leather Industries	1.9	94.1	13.1
Textile Industries	4.7	89.3	13.6
Knitting Mills	1.3	88.8	21.6
Clothing Industries	7.0	86.3	31.6
Wood Industries	2.7	27.4	61.5
Furniture and Fixtures	3.5	77.6	51.5
Paper and Allied Industries	4.7	49.7	16.6
Printing and Publishing	6.3	71.1	30.4
Primary Metals	5.6	63.1	20.1
Metal Fabricating	9.3	76.0	36.0
Machinery Industries	6.0	76.3	41.4
Transport Equipment	10.6	79.9	24.2
Electrical Products	7.8	89.9	13.6
Non-metallics	3.0	67.0	15.6
Petroleum and Coal	1.2	67.5	36.7
Chemicals	5.2	81.0	23.8
Miscellaneous	4.6	84.0	32.9
Total or average	100.0	70.0	26.1

Sources: Aggregated from Statistics Canada, *Labour Force, 15 Years and Over, by Industry Type, by Census Subdivision, by Residence, 1981*, Microfiche CTE 81B35, and a special tabulation for 1971 (6591-P01826-2B-1971).

Map 7
The Location of Manufacturing Industries, 1981

(a) High Value-Added Manufacturing

(b) Low Value-Added Manufacturing



Manufacturing Regions Within the Heartland

Map 7 shows where the various types of manufacturing are located in the axis. Specific locational concentrations of a particular industry type are indicated by symbols. Because the data are based on census divisions, the symbols have been placed at or around the major urban area in the county. An industrial type is regarded as significantly concentrated in a county if: (a) the county has more than 2% of the total axis labour force in that industry type; and (b) the industry contributes more than 5% of the manufacturing labour force in the county.

The industrial types have been divided into two groups on the basis of industry-wide estimates of value-added per worker in the manufacturing process. "Low value-added industries" tend to have low capital/labour ratios and pay relatively low wages, while "high value-added industries" tend to have high capital/labour ratios and pay relatively high wages. The contrast between the two maps (*see* Maps 7*a* and *b*) is remarkable. The high value-added industries tend to be clustered in the largest metropolitan areas: Toronto and Montréal. The concentration is also particularly evident in the "golden horseshoe", around western Lake Ontario from Oshawa-Whitby to Hamilton, and extending westward

along Highway 401 and rail routes to Kitchener-Waterloo, London, and Windsor-Chatham.

The low value-added industries, on the other hand, are dispersed. Some (such as clothing, furniture, and fixtures) are present in the two largest metropolises, but most are in the smaller towns beyond the major metropolises (Lebeau, 1982). There is a particular pattern to these industries in Québec; the textile industry is concentrated in the townships immediately to the east of Montréal, an area broadly defined in Map 7 as Cantons-de-l'Est, and wood and paper industries are found in the small towns (and Québec City) somewhat further east from Montréal in what Thibodeau and Holz (1977) describe as "Zone mixte".

This emergence of high and low value-added geographic concentrations of industry may be related to the differing availability of two factors of production—capital and labour—in the two provinces over the past few decades. Norcliffe and Stevens (1979) argue that with capital having been relatively more abundant than labour in southern Ontario, capital-intensive (and hence high value-added) industries have concentrated in that part of the axis. In Québec, labour has been relatively more abundant than capital, so more labour-intensive (and hence low value-added) industries have been located in that part of the axis.

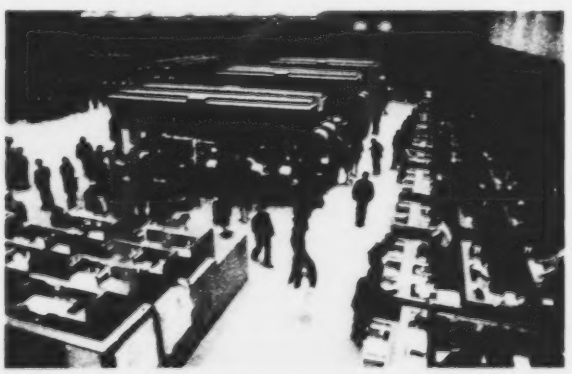
In summary, the major regions of industrial specialization are:

1. The East Axis Manufacturing Area:
   (a) The Montréal Region—mainly high value-added industries (transport equipment, electrical products, chemical products, and printing and publishing) and clothing (Gilmour and Murricane, 1975).
   (b) Cantons-de-l'Est—expanded to include the textile towns of Magog, Sherbrooke, Drummondville, and Cowansville. This region is closely linked with the clothing industry of Montréal (Hébert, 1976).
   (c) "Zone mixte"—where industries based mainly on wood are located in cities and towns such as Trois-Rivières, Shawinigan, and Athabasca (Brouillette, 1982). Québec City has a somewhat wider manufacturing base (Hulbert, 1976).
2. The West Axis Manufacturing Area:
   (a) The Golden Horseshoe—primarily in Toronto, Oshawa, Mississauga, and Hamilton. This is the largest concentration of manufacturing employment in Canada, with mainly high value-added manufacturing industries. The dominant industrial types are transport equipment (particularly automobile assembly, trucks, farm equipment), metal fabricating, primary metals, and electrical products.
   (b) London-Kitchener Corridor—involving newer high, and older low, value-added industries, with automobile manufacturing in St. Thomas, electrical products and machinery industries in London, Waterloo, and Brantford, and metal-fabricating industries in Kitchener and Guelph.
   (c) Windsor-Chatham—consisting almost entirely of high value-added automobile (MacDonald, 1980) and metal-fabricating industries.

Although the above regions comprise the bulk of manufacturing in the Windsor-Québec City axis, two areas of minor concentration should also be mentioned. First, the limited manufacturing employment in Ottawa-Hull has recently been expanding. The chief industry used to be pulp and paper manufacturing, but modern computer and communications hardware and software production, subsumed under the "electrical products" heading (Steed and DeGenova, 1983), is growing rapidly. The second area of minor concentration is in Sarnia, with its petro-chemical industry based on western resources.

A HEARTLAND OF OFFICE AND SERVICE ACTIVITIES

Although the axis is known as the manufacturing heartland of Canada, service (or tertiary) activities provide the most employment. The service activities listed in Table 9 employ almost three times more of the axis labour force than manufacturing, and the proportion of the labour force involved in this broad sector is increasing at a rapid rate. This shift of the labour force to service



Courtesy of the Toronto Stock Exchange

The Toronto and Montréal stock exchanges are barometers of economic activity. Chartered in 1874, the Montréal exchange is the oldest, while Toronto's is the largest in Canada. Between 10 and 12 million shares are traded on an average day at the TSE which lists 933 companies. In 1984, the TSE ranked ninth among world stock exchanges in terms of value traded.

activities (discussed in greater detail in Chapter Four) mirrors similar changes occurring in other highly urbanized, wealthy societies over the past few decades and suggests the emergence of a "post-industrial" society (Bell, 1976) or service state (Lang, 1974).

The Geographic Concentration of the Service Sector Labour Force

An interesting feature of the axis tertiary labour force is that, while the axis has a greater than expected concentration of the labour force in only three groups of activities (wholesale trade, finance, and business management services), there are a number of significant geographic concentrations (*see* Map 8). Since the tertiary sector labour force is generally distributed in accordance with the population served, concentration is measured in terms of expected population distribution (Preston, 1979). In Table 9, the concentration indices describe whether the axis has more (greater than 1.0) or less (less than 1.0) than expected of the labour force in a particular type of employment, based on the axis share

Table 9

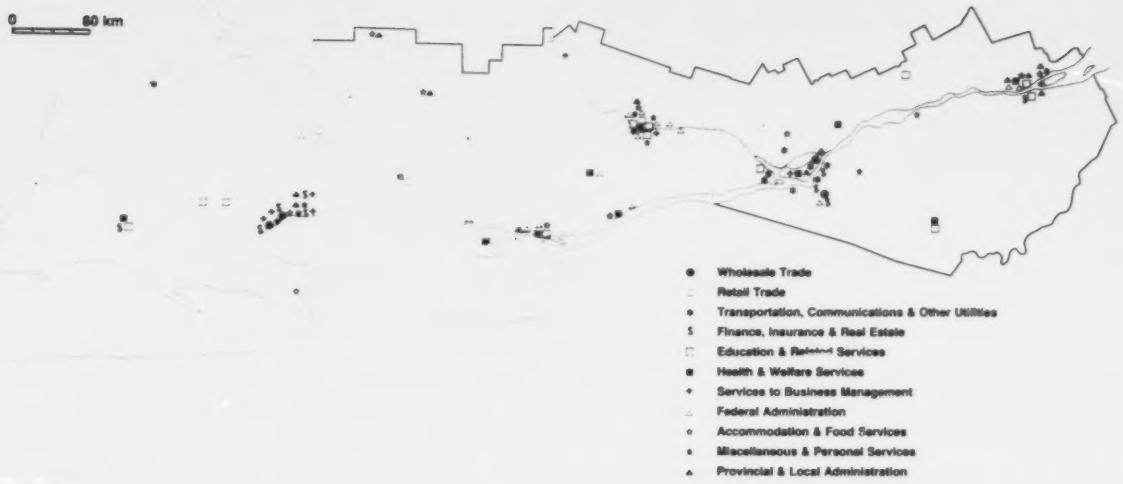
Distribution and Relative Concentration of Employment in the Major Tertiary Activities in the Axis, 1981, and Percentage Change in Labour Force, 1971-1981

Type of Tertiary Employment	% of Axis Tertiary Employment	Concentration Index*	1971-1981 % Increase
Transportation, Communications, etc.	10.97	0.95	39.9
Wholesale Trade	8.96	1.30	97.4
Retail Trade	17.40	1.01	46.9
Finance, Insurance, Real Estate	8.59	1.12	59.4
Education, etc.	9.63	1.02	31.1
Health and Welfare Services	10.65	1.01	61.1
Services to Business Management	6.71	1.13	113.6
Personal and Miscellaneous Services	8.43	1.08	51.8
Accommodation and Food Services	8.05	0.98	101.9
Federal Administration	4.81	1.01	23.0
Provincial and Local Administration	5.77	0.94	43.6
Other Government Employment	0.03	1.43	21.3
Total or average	100.0	1.04	55.7

* Based on national employment totals.

Sources: Aggregated from Statistics Canada, *Labour Force, 15 Years and Over, by Industry Type, by Census Subdivision, by Residence, 1981*, Microfiche CTE 81B35, and a special tabulation for 1971 (6591-P01826-2B-1971).

Map 8
The Location of Various Concentrations of Tertiary Activities, 1981



of the nation's population (54.2%). Because labour in the wholesale trade in the axis comprised 70.5% of the total national wholesale employment in 1981, the index is 70.5/54.2 = 1.30. In other words, a great deal more employment is in wholesale trade in the axis than expected on the basis of its share of the Canadian population. The index can therefore be regarded as a crude measure of excess (or deficit) service employment.

Although the axis does not have a significantly greater than expected share of the total service sector labour force, the three categories where a significant excess does occur are in precisely those areas of employment that a core is expected to dominate—business, finance, and wholesale distribution and repackaging. Furthermore, two of these groups are among the three which doubled in labour force between 1971 and 1981. The axis does not, however, have a greater than expected share of the national employment in federal government activities.

The geographic concentration of service activities is marked. Map 8 has been constructed from the same type of data set as that used for manufacturing, except for the measure of concentration. If a county has a concentration index of 1.15 or greater in a particular type of tertiary activity, that activity is represented by a symbol placed at the location of the largest city (or cities) in the census division. The expectation is, of course, based on the local census division population, and an index of 1.15 means that the county has considerably more people in the labour force in that category than its population size suggests.

Map 8 shows that Ottawa-Hull and Québec City, in particular, have a large "excess" labour force in service and governmental activities, and can therefore be regarded as having a labour force concentration in these activities. The metropolitan areas of Toronto and Montréal specialize in finance, services to business management, and wholesale trade. Two smaller cities, Kingston and London, are particularly dependent upon health and education-related (Polèse and Léger, 1979) activities.

The most notable feature of Map 8 is that the places having the most types of service activities with greater than expected shares of the labour force are the largest metropolises in the axis. The metropolitan areas of Toronto and Montréal provide a large variety of services to an extensive population, and many of these services exemplify the role of the core—finance, wholesale trade, and services to business. Ottawa-Hull is, as would be expected, the centre of federal government employment, and both Québec City and Toronto have strong concentrations of provincial public servants. Two minor regional service centres, London and Kingston, serve as education-health centres and have some financial activities. Most of the other urban areas that exhibit a concentration of the tertiary labour force do so in only one or two of the service categories: for example, Peterborough (retail trade), Sherbrooke and Guelph (university towns), and Huntsville and Ste. Agathe (recreational centres).

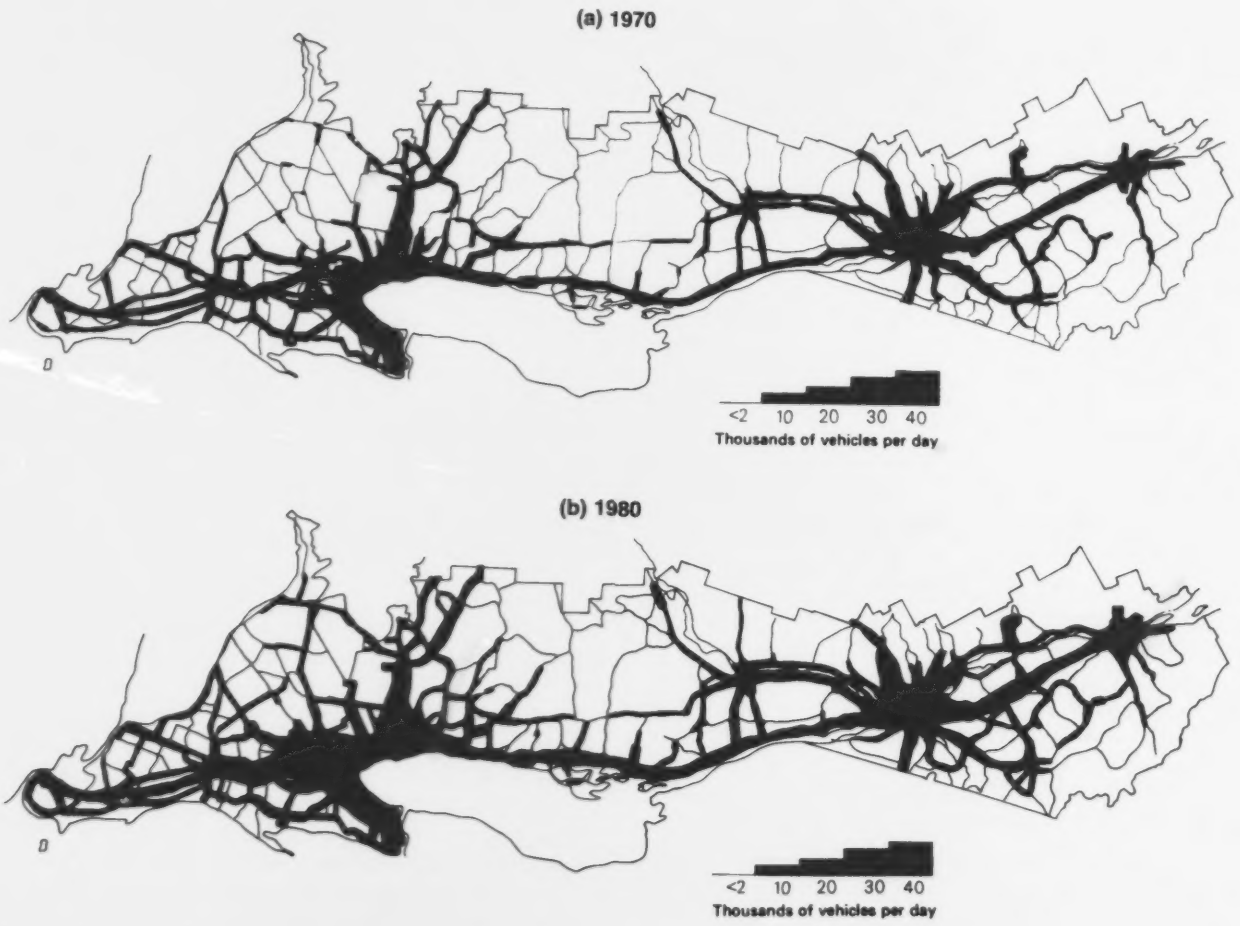
INTERACTION

The role of the axis as the core is demonstrated in patterns of trade, agriculture, manufacturing, and tertiary activities. These activities give rise to a flow of people, goods, and information that reflect the various geographic concentrations that have been identified. Furthermore, alterations in the pattern and direction of flows both within the core and between the core and the periphery indicate the ways in which the core/periphery arrangement may be changing. Two examples may serve to demonstrate the changing patterns of interaction; one concerns flows within the axis, and the second concerns those between the core and the periphery.

By far the largest share of the inter-city movement of people, and the greatest share of the movement of goods (by value), occurs by road transport. The maps depicting the average daily volume of road traffic within the axis in the early 1970s (*see* Map 9*a*) and early 1980s (*see* Map 9*b*) demonstrate in terms of interaction the structure of the core and its changing geography. Two large metropolitan nodes—Montréal and Toronto—clearly serve as the generators or destinations of most flows. Two lesser nodes—Québec City and Ottawa-Hull—serve as secondary organizing focii. The major flows occur on routes that are now at least four-lane highways (*see* Map 10), and the main direction of traffic follows the corridor from Windsor to Québec City.

Map 9

Traffic Volumes on the Main Roads Within the Axis



Sources: Yeates, 1975; Ontario Ministry of Transportation and Communications, 1983; and Québec Ministère des Transports, 1979.

Map 10
Four-Lane Roads Within the Axis, 1982

The major changes in the within-axis pattern of flows, which can be discerned from a comparison of Maps 9*a* and *b*, are, perhaps, three-fold. First, the volume of traffic across the entire axis has increased considerably. It is interesting to note that the inter-provincial flow of rental trucks between Ontario and Québec increased by more than three times in the 1970s (Yeates, 1982). Second, the increase in traffic appears to be greatest in southern Ontario, particularly from Toronto to Kitchener-Waterloo, London, Windsor, and north to Barrie. Third, the metropolitan area of Ottawa-Hull is now a much more conspicuous centre than it was in the early 1970s and so, to a lesser degree, is Québec City. The major integrative link between the two provinces, along the lakeshore (Highway 401 in Ontario, and Rte 20 in Québec) and St. Lawrence River, is particularly important and demonstrates a much greater volume of interaction between Montréal and Toronto in the early 1980s than seems to have existed in the early 1970s.

A similar pattern of increased volume, but a much more distinct indication of geographic change in direction, is exhibited in the interaction (as measured by airline passengers) between the major cities of the core and periphery (*see* Table 10). This data is from a highly biased source of information, since there are other more competitive means of transport for short-haul trips (road and rail), and air transport is expensive. Nevertheless, the data provide a good representation of flows involving business and political/administrative purposes.

The largest volume of traffic is generated by the short-haul flights between metropolitan areas within the heartland, though the growth rate of this traffic has been a great deal less than that involving many western cities. In particular, the interconnections between Calgary, Edmonton, and Vancouver, and between these three metropolises and Toronto, have increased enormously. On the other hand, the links between Montréal and the major cities of the periphery are not strong at all, the Toronto-Halifax link being stronger than the Montréal-Halifax flow. This information reveals a clear trend of Toronto developing as the major link between the axis and the periphery, and also of a strong set of links emerging within the western periphery.

CONCLUSION

The Windsor-Québec City axis plays a key role in the Canadian economy. There are, however, significant changes occurring both within the axis and between the area and the rest of the nation. Since these changes have a vital impact on the spread of urban areas, it is important to examine the way in which urban growth responds to change. Urban development involves the accumulation of a built environment, so the current locations of urban developments are really the product of past economic forces, and current economic trends have only a marginal effect on the spread of urban areas in the immediate future. Consequently, the spread of urban areas in the axis over a long time period should be examined in a broader framework, in order to assess possible patterns of future growth, stagnation, or decline. Since the purpose of this study is to relate these various patterns of urban development to land consumption, it is also important to present the information concerning the growth and spread of urbanism in a rural/urban framework. Such a framework is presented in the following chapter.

Table 10

The Changing Pattern of Interaction Between the Core and the Periphery: Airline Passenger Volumes, 1971 and 1981 (000s of Passengers, Inbound and Outbound)

Metropolitan Pair	1971	1981	% Change
Montréal-Toronto	685.8	1,115.2	62.6
Calgary-Edmonton	254.8	690.2	170.9
Ottawa-Toronto	326.6	558.9	71.1
Toronto-Vancouver	182.8	546.7	199.1
Calgary-Vancouver	179.4	472.3	163.3
Calgary-Toronto	86.7	432.8	399.2
Edmonton-Vancouver	144.7	378.1	161.3
Edmonton-Toronto	72.8	306.8	321.4
Toronto-Winnipeg	163.1	300.9	84.5
Halifax-Toronto	103.1	228.0	121.1
Vancouver-Winnipeg	85.1	176.3	107.2
Montréal-Québec	90.1	125.7	39.5
Halifax-Montréal	86.1	121.5	41.1

Source: Statistics Canada, *Airline Passenger Origin and Destination: Domestic Report*, Cat. No. 51-204.

Courtesy of Triple Five Corporation Ltd. Photo by David Buston

The West Edmonton Mall, with its 827 stores and services and 15,000 permanent jobs, illustrates the significance of the service sector. The 45-hectare site houses 483 000 m^2 of mall space and the world's largest parking lot, for 14,000 cars. Prior to the opening of Phase III, more than 440,000 people per week visited the huge complex. About 42% of these shoppers were resident outside of Alberta. The Ghermezian family, owners and developers of the mall, recently visited Ontario and Québec to consider potential sites for a similar project.

URBAN GROWTH IN THE AXIS

The first chapter emphasized that a relatively weak core/periphery situation existed in Canada at the turn of the century. Two incipient cores around Montréal and Toronto had developed, but the level of economic integration between these two focii was somewhat limited. The second chapter demonstrated that a highly integrated core region has developed, one that still focuses on these two major metropolises, but that also involves the entire axis. Furthermore, a strong core/periphery relationship has also emerged between central Canada and the rest of the country. The purpose of this chapter is to define more concretely the period during which the strong core/periphery situation became evident, establish a cartographic procedure for examining the concomitant urban development that occurred, and use this procedure to trace the stages in the development of the macro-urban region.

THE EMERGENCE OF THE CORE

Urban development in the axis is influenced by a number of population-related factors: first is the relative concentration of the Canadian population in the axis area; second is the general rate of population increase; and third, as is evident in the significant representation of a number of ethnic groups, is the amount of immigration. This latter factor is particularly important, because in the past few decades immigrants have been primarily destined for the largest metropolises in the axis. Information concerning these three population factors is presented in Table 11. The estimate of the total population back to 1921 includes Newfoundland, except for the immigration data. This inclusion of Newfoundland thus represents the core/periphery situation more accurately, but does not seriously affect the immigration data because foreign immigration to the province is quite small.

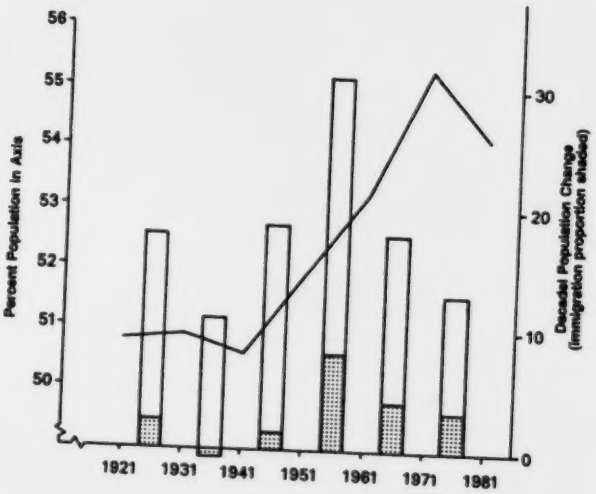
The three sets of information detailed in Table 11 are presented for illustrative purpose in Figure 4. The solid line describes the change in population share in the axis between 1921 and 1981; the bars indicate the population increase for each 10-year intercensal period; and the dark areas within the bars indicate the proportion of the increase accounted for by immigration. These three indicators show that population change and urban development can be discussed with respect to three distinct periods: 1921-1951, the period of consolidation; 1951-1971, the period of concentration; and from 1971 on, the period of deconcentration.

◀ S.S.C. – Photo Centre Library – A.S.C. (72-4474)

In the first period, the embryonic urban systems that had developed in Québec (Brunet, 1980*a*) and Ontario (Marshall and Smith, 1978) became firmly established, with both large and small urban areas experiencing generally similar growth rates (Russwurm and Thakur, 1981). Some manufacturing was established in many settlements in the 1901-1921 period, with industries receiving particular stimulus during the 1914-1918 war years (Kerr, 1982). The years of extreme cyclical economic swings between 1921 and 1940 were ones in which the existing urban pattern became entrenched, but no dramatic urban growth occurred. The proportion of the country's population in the axis remained at about 51% of the national total for the entire period, and the rate of population growth and proportion of that growth accounted for by immigration was quite low.

Figure 4

The Proportion of Canada's Population Located in the Windsor-Québec City Axis, 1921-1981 and Ten-Year Population Growth Rates



This period of consolidation came to an end with the growth of manufacturing in the axis and the strong demand for raw materials during the Second World War. Population drifted to the axis area, but the impact of this shift was not really felt until the 1951-1971 period, when economic prosperity was translated into high rates of natural population increase and large amounts of

Table 11

Axis and Canadian Population (000s): Change and Net Foreign Immigration by Ten-Year Intervals, 1921-1981

	Axis		Canada		
Census Year	Population	Concentration*	Population	% Increase	% Immigration
1921	4,597	50.8	9,051		
1931	5,421	50.9	10,659	17.8	14.2
1941	5,971	50.6	11,810	10.8	– 8.1
1951	7,272	51.9	14,009	18.6	7.9
1961	9,745	53.2	18,328	30.8	25.5
1971	11,920	55.3	21,568	17.7	21.7
1981	13,194	54.2	24,348	12.9	24.2

* Concentration measures for 1921, 1931, and 1941 are slightly different from those in Yeates, 1984*a*, due to inclusion of Newfoundland.

Sources: Leacy, 1983, Series A339-349; population estimates for Newfoundland prior to 1951 in *Annuaire du Québec, 1972*; immigration estimates for 1971-1981 from total increase-natural increase with natural increase data derived from Statistics Canada, 1983, *Vital Statistics, Vol. 1, Births and Deaths*, Cat. No. 84-204.

domestic and foreign immigration (Polèse, *et al.*, 1978). Some of the key factors stimulating this economic prosperity were: strong external demand for raw materials produced in the periphery (wood, oil and gas, and other minerals), but often refined and processed in the core; the devaluation of the Canadian dollar in the early 1960s, which stimulated manufacturing in the axis; the Canada-U.S. Auto Pact Agreement, which resulted in the creation of thousands of jobs in southern Ontario (Richmond, 1974); emergence of the labour-intensive "service state" (Lang, 1974), which again created many urban jobs; the boom in the housing construction industry, stimulated by the high rates of family formation and fertility after 1945; and the concomitant growth of public investment in urban infrastructure and transport systems, such as the St. Lawrence Seaway, limited-access highways and autoroutes (Saint-Laurent, 1983), and the subway systems in Montréal and Toronto.

The period from 1971 on appears to represent a beginning of the reversal of the trend of the previous few decades. It is not, however, clear whether the deconcentration of the 1970s represents a weakening in the core/periphery relationship (Robinson, 1981; Bourne, 1977/78), or merely a pause or consolidation following the intense years of concentration of population and economic activities (Hooper, *et al.*, 1983). This period is quite different from that of 1951-1971, since deconcentration has occurred at a time of low population growth and lower immigration levels in the country as a whole. Urban population growth rates within the axis have therefore generally declined as well. The economic circumstances of the 1970s—escalating oil prices, rapid inflation followed by devaluation of the dollar in the 1980s, restructuring of the automobile industry, a softening in world demand for raw materials, and a decline in some of the traditional manufacturing industries—have all had a modifying effect on urban growth within the axis.

MAPPING URBAN DEVELOPMENT

The area defined as the Windsor-Québec City axis is quite large (175 000 square kilometres), with a rectangular shape about 1 100 kilometres long and 200 kilometres wide. This extensive area is larger than England and Wales combined and almost the size of Washington State. Since the objective of this section is to document and discuss the changes in urban develop-

ment that have occurred over six decades, the geographically-based units for which information is compiled must be small enough to show spatial variations in sufficient detail, but large enough to permit the establishment of a comparable time series.

Defining the Mapping Units

After some experimentation it was determined that, for a study area the size of the Windsor-Québec City axis, the most useful statistical unit is the census subdivision. Counties, or census divisions, are too large, though they have to be used for some types of information. Census tracts are much too small and not available for much of the axis area. Census metropolitan areas (CMAs) and census agglomerations (CAs) define only the larger urban places, do not provide complete coverage for the entire axis, and frequently understate the geographic extent of urban development.

Each census division contains, on average, about eight census subdivisions, and these smaller units have been used for census purposes throughout this century. The units in Ontario usually coincide with township boundaries, and in Québec they are invariably coincident with cantons. The boundaries of these units are relatively consistent over time, though the changes that have occurred create time-consuming problems when a consistent data file for a number of dates has to be compiled. There are, in 1981, 1,160 census subdivisions in the axis area. In the 1971-1981 period, there were about 250 boundary changes, mostly minor in nature, though a few were related to regional government formation in Ontario and were quite substantive.

Furthermore, the census subdivisions are not roughly comparable in size. Because density figures are to be calculated for the population information, there should be as little variance in the size of the census subdivisions as possible. Unfortunately, townships in Ontario are invariably two or three times larger than those in Québec. This particular problem has been partially resolved by aggregating the census subdivisions in Québec, so that the mean size (and variance) of "modified" census subdivisions in that province is almost the same as the mean size and variance of those in Ontario. A new, modified set of 684 census subdivisions has therefore been created for the axis area (with an average size of 252.4 square kilometres) and, while there are still noticeable differences in sizes between these units, gross provincial discrepancies have been reduced. Henceforth, when the term "census subdivision" is used with reference to the maps of urban expansion, the units involved will be the modified set.

The aggregation procedure for Québec, and for a few cases in Ontario, diminishes the number of boundary corrections and population re-adjustments necessary to make all the modified subdivision boundaries for each decadel census since 1921 correspond to those in 1981. A large number of changes still had to be made, although, apart from the adjustments resulting from recent regional government formation in Ontario and county reorganization in Québec, the population involved in each correction is quite small. The population of all villages, towns, and cities located along boundaries have also been assigned to appropriate census subdivisions on a constant prorated basis for each time period.

The result of these adjustments is a file set of information related to the population of the axis area for 684 modified census subdivisions for the 1921-1981 period. Each census subdivision has boundaries conforming with those existing in 1981, and the information pertaining to each of the units is comparable over time. Change over a 60-year time period can therefore be analysed for each of these relatively small units, and problems arising from boundary changes have been virtually eliminated. It is also possible to compare densities across the entire axis area, because the sizes of the census subdivisions are roughly similar, though by no means equal.

Mapping Urban Development: Theory

Given a fairly consistent set of population information, the next step is to define what is meant by urban, since this study revolves around questions pertaining to the spread of urbanism in the axis. Following Wheatley (1983), it may be argued that the urban concept involves two aspects: urbanization and the urban process. The first relates simply to the proportion of the population that resides in urban places, and the second involves the ways in which large numbers of the population become involved in some manner with the activities (public and private) of the city.

The notion of urbanization does, of course, underlie material published from the census, because the population is divided initially into rural and urban components on the basis of the size and density characteristics of the area in which an individual's residence is located. Thus, in the 1981 Canadian Census, urban refers to "an area having a population concentration of 1,000 or more and a population density of 400 or more per square kilometre." These echoes of Wirth's (1938) concept of urban characteristics (size, density, heterogeneity) are also found in the U.S. Census (Bureau of the Census, 1984).

The distinction of urban from areas non-urban in land-use analysis is also rooted directly in the urbanization component of the urban concept. For example, the Canada Land Inventory defines urban as "land used for urban and associated non-agricultural purposes," and includes the built-up area (defined as "all compact set-

tlements"), mines, quarries, sand and gravel pits, and outdoor recreation facilities (Scace, 1981). This definition, like the rural/urban distinction based on size and density, while extremely useful, does not incorporate some aspects of the urban process that are important when analysing present and future rates of conversion of rural land to urban uses.

The urban process is a much more difficult concept to define in concrete terms because it involves the *ways* in which large numbers of the population become involved with the activities of the city. For example, one way in which people become involved with city activities is through the collective consumption of services (public housing, social welfare services, and so forth). At one extreme, it may be argued that in situations in which a central government provides most of the services, there is no distinction between urban and rural (except in cases of spatial variation of adoption), because all the population is involved in the collective consumption of publicly-provided goods (Dunleavy, 1980). This extreme politically-oriented view is not, however, appropriate here, since one clear way in which people become involved in the activities of urban areas is through employment in urban-based activities. The urban process could then be defined by examining the degree to which the population of an area (census subdivision) is oriented toward urban-based employment opportunities.

Mapping Urban Development: Practice

The objective is therefore to define the degree to which the population of each census subdivision in the axis may be regarded as urban. Since the most common characteristic of urban is that it is a place with a high population density, the objective of the empirical analysis is to decide the level, or levels, of population density at which a census subdivision becomes urban. The actual information used to define the appropriate density at which a census subdivision becomes urban is based on (1) the employment aspect of the urban process, and (2) the urbanization component represented by the size of settlements located in the subdivision.

Although both Russwurm (1970) and Krueger (1978) also focus on density as the summary indicator, the approach used in this study is quite different. First, the theory and methods incorporated in this study are more clearly linked. Second, the definitions used are based on a wider geographic coverage, since Russwurm's study is related to the Toronto-Stratford corridor and Krueger's is limited to the Niagara Peninsula. Third, the unit of analysis, the modified census subdivision, is considerably larger than the township concession blocks used by Krueger and the aggregations of blocks used by Russwurm.

Wayne Bond

When urbanites move to rural areas, the resulting mix of agriculture and ex-urban residential land uses is not always compatible. Normal farm operations may be negatively affected or constrained because of trespassing and damage or residents' complaints about odour, noise, or slow-moving equipment.

The set of information used to relate the employment component of the urban process to densities is the proportion of the population in a census subdivision in 1981 that is classified by the census as "urban non-farm" (Census of Agriculture, special tabulation, 1982). The population of a census subdivision is split into "rural" and "urban" according to the "population concentration of 1,000 and 400 persons/square kilometre" rule described previously, and then both components are subdivided into farm and non-farm on the basis of occupation:

rural farm:	all persons living in rural areas who are members of households of farm operators living on their farms for any length of time during the 12-month period prior to the census;
rural non-farm:	all persons living in rural areas who are not members of the households of farm operators;
urban farm:	all persons living in population concentrations defined as urban who are members of the households of farm operators;
urban non-farm:	all persons living in population concentrations defined as urban who are not members of the households of farm operators.

The definition "urban non-farm" isolates in a reasonably restricted way the population of a census subdivision that can be expected to be involved with urban-oriented economic activities. The combined groupings of rural farm plus rural non-farm plus urban farm will primarily

include the population dependent largely upon agriculture-oriented economic activities.

The general relationship between the population density of a census subdivision and the proportion of the population that is classified as urban non-farm, for all census units with an urban non-farm proportion greater than 10%, is indicated in Figure 5. Although the cloud of points demonstrates that the greater the proportion of the population of a census subdivision classified as urban non-farm the greater the population density, there are perhaps three distinct components to the pattern. First, at a density of about 500 persons per square kilometre, the population of a census subdivision

Figure 5

The Relationship Between Population Densities and Percentage of Urban Non-Farm Population for Census Subdivisions, 1981

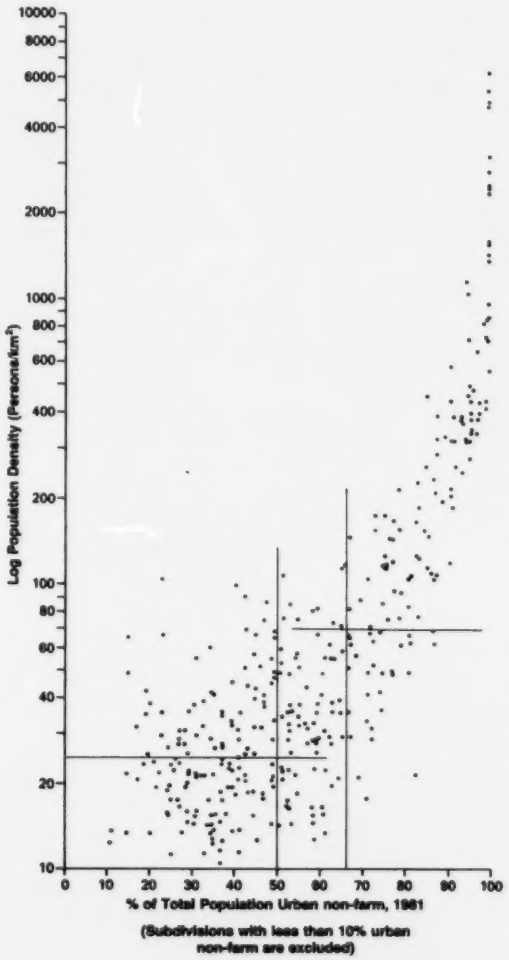
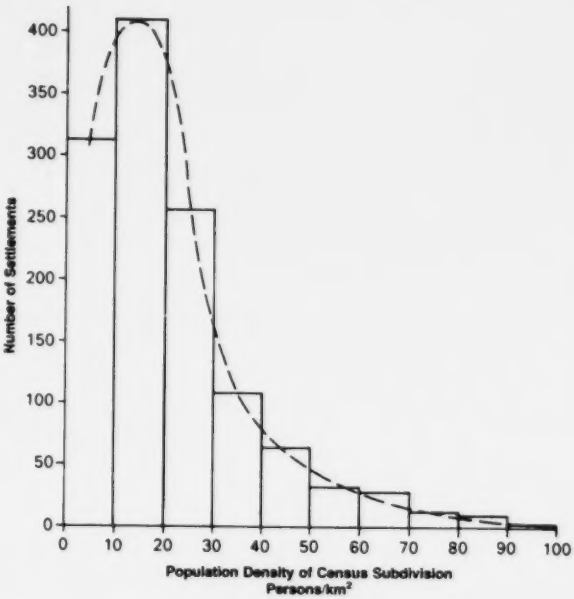


Figure 6

Frequency Distribution of Settlements in Census Subdivisions of Various Densities



becomes almost completely urban non-farm. Second, in census subdivisions with population densities of less than 500 persons but greater than about 60 persons per square kilometre and with an urban non-farm percentage higher than 66%, the relationship between the two variables is quite strong. Third, where densities are less than 60 persons per square kilometre and the urban non-farm percentage is less than 66%, the relationship between the two variables is weak, because the variation in population density for any given percentage of the urban non-farm population is quite high. The general conclusion is that, in terms of the specific definition of urban process used, a census subdivision in the axis is exhibiting urban characteristics when its population density is about 60 persons per square kilometre.

The urbanization aspect of the urban concept is derived by examining the actual size of settlements and relating these to the population densities of census subdivisions. In Table 12, the number of settlements of particular sizes is cross-tabulated against the population density of the census subdivision in which they are located. In the Windsor-Québec City axis in 1981, for example, 174 settlements in the 1,000-2,500 population range are located in subdivisions that have a density between 10 and 20 persons per square kilometre. There are a substantial number of places with a population of less than 5,000 in the axis (Hodge and Qadeer, 1983). The number of settlements reaches a peak in the 10-20

Table 12

Size Distribution of Settlements Among Census Subdivisions of Varying Population Densities, 1981

Population Density (persons/km²)	Size of Settlement					
	>1,000	1,000-2,500	2,500-5,000	5,000-7,500	7,500-10,000	10,000-50,000
0-10	210	93	11	0	1	0
10-20	195	174	41	2	3	4
20-30	88	103	66	12	2	5
30-40	27	47	34	13	5	4
40-50	22	30	11	9	4	8
50-60	11	9	12	9	1	7
60-70	6	11	10	5	2	7
70-80	1	7	5	2	1	6
80-90	3	7	1	2	2	6
90-100	1	0	0	1	0	3
100-120	0	1	0	0	0	10
120-160	0	0	1	0	0	9
160-240	1	0	0	0	0	13
240-400	0	0	0	0	0	16
400-720	0	0	0	0	0	7

persons per square kilometre density interval (*see* Figure 6) and then decreases rather rapidly as density increases. Low-density subdivisions (0-10 persons per square kilometre) have virtually no centres with populations above 5,000, since this size of settlement only begins to become reasonably numerous with census units in the 20-30 persons per square kilometre range.

Since rural census subdivisions are characterized by small settlements, and if small is defined as places with less than 5,000 people (Dahms, 1980), then rural areas exist most commonly in census units with a density of about 25 persons per square kilometre or less. Census subdivisions with a density of less than 10 persons per square kilometre also have virtually no centres with more than 2,500 people, so it would be useful to distinguish these sparsely-populated areas from the more heavily-populated areas in the rural environment.

The degree to which a census division may be defined as "urban" or "rural" may therefore be indicated on the basis of three critical values—60, 25, and 10 persons per square kilometre which delineate four levels in the density continuum:

(1) Census subdivisions with a population density greater than 60 persons per square kilometre (or 155 persons per square mile) are described as urban. Above this value, more than two-thirds of the population of a census unit is generally urban non-farm, there are very few

small villages and towns, and larger places become more evident. For example, Chatham (40,000), Brockville (26,000), Lachute (52,000), Cobourg (13,000), and Cowansville (13,000) are located in census subdivisions with densities in the 60-80 persons per square kilometre range.

(2) Subdivisions in the 25-60 persons per square kilometre category (65-155 persons per square mile) are described as semi-urban, since between 33% and 66% of their populations are classified as urban non-farm. These census units contain a fairly large number of small villages and towns, but also a good number of places in the 5,000-10,000 population range, with some having populations greater than 10,000. Most of these towns and cities appear to be residential in nature, because they are located within the commuting fields of major metropolises (for example, St. Remi, Contrecour, Buckingham, Newcastle, Paris). Other service and industrial towns are some distance from large metropolises (for example, Montmorency, Walkerton, and Plessisville).

(3) Census subdivisions in the 10-25 persons per square kilometre range (25 to 65 persons per square mile) are defined as rural, because generally less than 50% of their population is classified as urban non-farm. A particular characteristic of areas in this category is the large number of small settlements (such as St. Denis, Pierreville, Elmer, and Bayham), classified as rural service. There are also some larger places (for example, Charlottenburg, Oro, and Princeville) with a small manufacturing base.

(4) The areas with a population density of less than 10 persons per square kilometre (less than 26 persons per square mile) are defined as "sparsely populated". The census units in this category generally have less than one-third of their population classified as urban non-farm, and the relatively large number of settlements within them are quite small (less than 2,500 population).

The procedure for defining "urban", and mapping the spread of urbanism throughout the axis, will use these four categories. Since these categories have been empirically defined on the basis of 1981 information, it will be interesting to observe how they apply for earlier time periods.

Mapping Urban Development: A Comparison of Different Schemes

The method used for defining urban in this study is therefore founded on a clear conceptual base, and is also somewhat different from those frequently used in discussions of urban development (e.g., Parenteau, 1978). Nevertheless, after a detailed analysis of a number of ways of defining urban and rural, Parenteau suggests a four-fold scheme—urban, pseudo-urban, rural non-farm, and rural farm—that is quite similar to the one proposed. The four-fold classification is also similar to the one established by Russwurm (1970) and used in Yeates (1975). The Russwurm scheme has also been applied with different benchmarks (*see* Table 13) by Krueger (1978).

It would be useful to discuss briefly the similarities and differences in the various benchmarks that have been used to analyze the geographic spread of urbanism in central Canada. Russwurm used data compiled from assessment rolls, aggregated into blocks averaging 18 square kilometres in area (compared with the 252.4 square kilometre average size of census subdivisions used in this study), for a corridor comprising 31 census subdivisions from Stratford to Brampton at the western edge of Metropolitan Toronto. The rural density (10 persons per square kilometre) is defined on the basis of the average farm population that has existed for a number of decades and, therefore, excludes the non-farm rural population. The critical value separating the semi-rural from the semi-urban (19 persons per square kilometre) is where the population density in the area changes from being generally more than half non-farm to invariably less than half non-farm. The critical value separating urban from semi-urban areas is established on the basis of the number of residence parcels that usually give rise to a need for urban-servicing infrastructure, estimated to be 46 persons per square kilometre. The Russwurm classification, based on 1941-1966 information, is fairly close to that derived for this study, though the densities defined at the "urban" end of the scale are about 20% lower. The method used to obtain the benchmarks for the different categories, however, is based more on farm densities, because his rural category really means farm population only.

The critical values separating the different categories are much higher in Krueger's study (*see* Table 13) of the Niagara Fruit Belt. The population data in this case are compiled on the basis of concession blocks, which average about 1.25 square kilometres in area. Krueger argues that, since the value of agricultural production in this area is extremely high and farms are consequently quite small, population densities in rural areas are high and the critical values separating the various categories must be much greater than those used by Russwurm.

Table 13

A Comparison Between Different Benchmarks Used to Distinguish Between Urban and Rural Census Units (People/km²)

Nomenclature	Krueger (1978)	Russwurm (1970)	Nomenclature	Yeates (1985)
Urban	over 93	over 46	Urban	over 60
Semi-urban	39-93	19-46	Semi-urban	25-60
Semi-rural	26-39	10-19	Rural	10-25
Rural	less than 26	less than 10	Sparsely Populated	less than 10
Average unit size (km²)	1.25	18		252.4

Sources: Krueger, 1978; and Russwurm, 1970.

For example, the critical value separating semi-urban from semi-rural is the average density of the farm population in the fruit-growing part of the region (39 persons per square kilometre). The other critical values are correspondingly greater.

The benchmarks, or critical values, used in this study have therefore been defined on the basis of a different methodology, developed from a particular theoretical view of the components of the urban concept. The values used have been obtained from sets of information pertaining to the axis as a whole, and not to a particular part with unique characteristics. The proposed categories and benchmarks are considered appropriate for tracing the spread of urbanism throughout the entire axis and for gauging the effect of this expansion on the consumption of land for urban purposes.

THE SPREAD OF URBAN AREAS

The spread of urban areas across the axis since 1921 has been fairly consistent through the decades (*see* Maps 11 through 14). The map for 1921 (*see* Map 11) shows that the basic skeleton of the urban system was in place, though settlements had not spread outward too much. While about 50% of the axis population at that time (*see* Table 14) was located in census subdivisions defined as urban, these census units comprised just more than 4% of the area under consideration. By 1981, however, the census subdivisions defined as urban comprised 15% of the area of the axis and contained more than 80% of the axis population (*see* Map 14). Furthermore, the census units defined as urban and semi-urban have converged by 1981 to form an almost continuous macro-urban strip, with about 12 million people between Windsor and Québec City, though the infertile Shield forms a physical wedge between southeastern Ontario and Ottawa-southern Québec.

Table 14

Proportion of Axis Population and Area Defined as Urban: 1921, 1951, 1971, and 1981

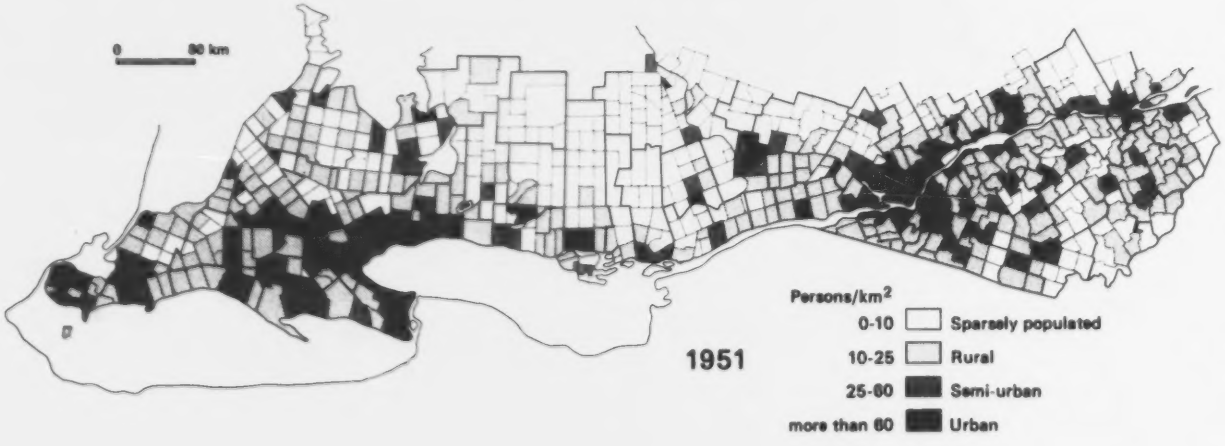
Date	Area %	Population %
1921	4.2	50.8
1951	7.7	67.7
1971	12.7	78.4
1981	15.1	81.1

Map 11

Areas Defined as Urban, Semi-Urban, Rural, and Sparsely Populated in the Windsor-Québec Axis, 1921

Map 12

Areas Defined as Urban, Semi-Urban, Rural, and Sparsely Populated in the Windsor-Québec Axis, 1951

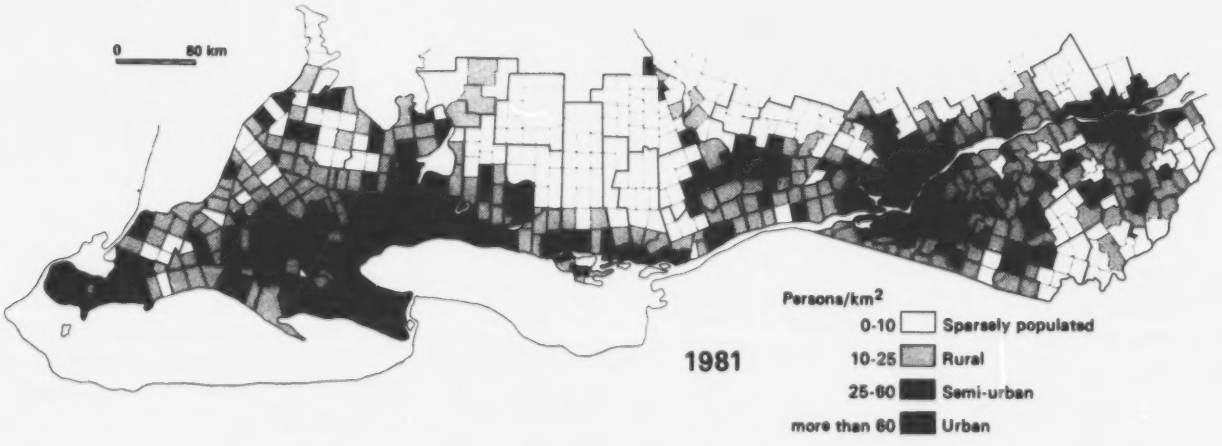


Map 13

Areas Defined as Urban, Semi-Urban, Rural, and Sparsely Populated in the Windsor-Québec Axis, 1971

Map 14

Areas Defined as Urban, Semi-Urban, Rural, and Sparsely Populated in the Windsor-Québec Axis, 1981

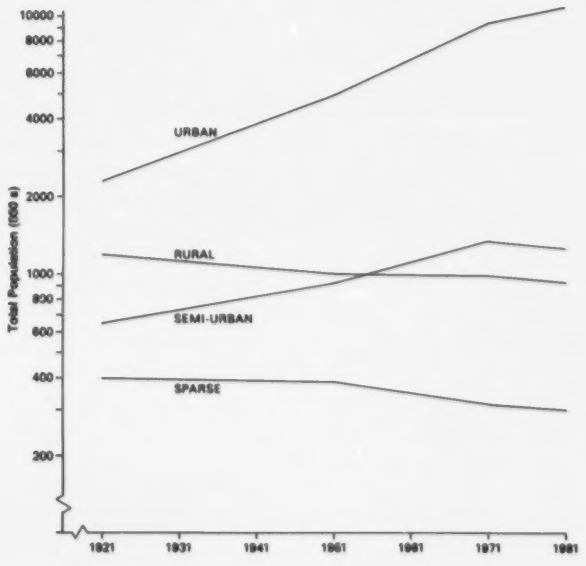


This physical control points to two general characteristics of the density maps. First, the area defined as "sparsely populated" appears to be fairly consistent throughout the period represented, with the Shield area and Appalachian intrusion being inimical to permanent settlement for most people. In fact, the area included in this category has decreased by only 15%, while the population it contains has declined by only about one-fifth. Second, urban expansion has occurred in a basically east-west corridor fashion, with very little urban expansion to the north except from Toronto.

Urban Growth in the Period of Consolidation, 1921-1951

The urban response to comparative prosperity in the 1920s, economic depression in the 1930s, and the exigencies of war in the 1940s was slow but steady population growth in most settlements, with the larger urban centres growing perhaps faster than the smaller settlements. In fact, people across the country, but particularly within the axis, were moving from rural to urban areas. While the population located in census subdivisions defined as urban more than doubled between 1921 and 1951 (*see* Figure 7), the population in areas defined as rural declined. This general consolidation of growth within and around census units classified as urban in 1921 is apparent in Map 12, which exhibits little spatial change, other than an increase in urban intensity, over Map 11. The urban concentration of population increases in this period is exemplified in Map 15, which illustrates the variation in rates of population change in census subdivisions across the axis. Nearly all census subdivisions with settlements having a 1921 population of greater than 10,000 experienced an increase greater than that for the country as a whole. Depopulation, however, occurred in both the rural areas and on the Shield.

Figure 7
Proportion of Axis Population Residing in Areas Defined as Urban, Semi-Urban, Rural, and Sparsely Populated, 1921-1981



The tendency for the greatest population growth to occur in the largest centres is illustrated in Table 15, which contains information and the definitions used for the four largest metropolitan regions in the axis. In order to have the information comparable for the entire set of years under study, the urban areas of Ottawa-Hull and Québec City are defined by a 25-kilometre radius, the distance around these cities embracing census subdivisions defined as urban in Map 14 (1981). The urban regions pertaining to Montréal and Toronto are defined as within a radius of 65 kilometres from the centre of each, since it is from within this area that most of the commuting to the two major municipalities occurs (Simpson and Cromie, 1977). The areas included within Ottawa and Québec City differ, and, because of Lake Ontario, the actual land area included within Toronto is a great deal less than that for Montréal.

The information in Table 15 demonstrates not only the concentration of the axis population in these major metropolitan areas, but also some of the cyclical economic effects of the different periods. During the 1920s, manufacturing and other types of employment increased considerably in Montréal and Toronto, and these two urban regions grew at a much greater rate than the rest of the axis. After the minor boom in federal employment in Ottawa during the war years, that area grew at the same rate as the rest of the axis, but the Québec region grew at a greater rate with the increase in trade, shipbuilding, and ship repair activities that followed the First World War. The shift toward the larger metropolises slowed during the depression years, and the small amount of growth that did occur was a result of the increase in economic activity generated by the Second World War in Europe. Then, during the flurry of the war effort of the 1940s, growth concentrated in the major metropolises once again, and the axis emerged in the 1940s with an industrial economy (Britton and Gilmour, 1978) that placed Canada among the leading manufacturing countries in the world.

Map 15
Population Change, 1921-1951

Table 15

The Population Concentration (000s) Within Four Major Urban Regions During the Period of Consolidation, 1921-1951

Metropolitan Region	1921		1931		1941		1951	
	Population	% in Axis	Population	% in Axis	Population	% of Axis	Population	% of Axis
Montréal (within 65 km)	1,013	22.0	1,320	24.4	1,487	24.9	1,840	25.3
Toronto (within 65 km)	929	20.2	1,200	22.1	1,334	22.3	1,696	23.3
Ottawa-Hull (within 25 km)	177	3.9	206	3.8	246	4.1	305	4.2
Québec City (within 25 km)	157	3.4	208	3.8	245	4.1	321	4.4
% within 4 metropolises		49.5		54.1		55.4		57.2

Urban Growth in the Period of Concentration, 1951-1971

Apart from a brief recession in the mid-1950s, the period from 1951 to 1971 was one of almost continuous economic growth, matched by unprecedented urban development within the axis. The axis grew faster than the rest of the nation and most areas experienced an increase in population (except on the most marginal lands), but most of the growth occurred in the census subdivisions defined as urban (*see* Maps 12 and 13). The urban-located population within the axis almost doubled to 9.5 million by 1971, whereas the population of the country as a whole increased by a little more than 50% in the two decades (*see* Figure 7). On the other hand, rural depopulation continued (Keyfitz, 1962), particularly with large-scale farm abandonment on the marginal lands in the sparsely-populated part of the axis (Parson, 1984).

The outcome of this period of high natural population increase, heavy immigration, and great growth in employment in manufacturing and service industries was a surge in metropolitan growth and expansion (Brunet, 1980*b*). The population became more concentrated in the larger urban areas (*see* Table 16), so that by 1971 the share of the axis population located within the four major metropolitan regions had increased to more than 64%. In particular, the metropolitan region around Toronto had a larger population than the area around Montréal. This surge in metropolitan expansion around Toronto and into southwestern Ontario is related to the growth of industry, large-scale immigration, and the gradual shift in financial and office activities from Montréal to Toronto (Dagenais, 1969).

At the same time as the population concentrated into metropolitan areas, there was also a deconcentration, or suburbanization, of population and economic activities within these regions (Polèse and Turpin, 1972; Bourne, 1977/78). This is illustrated in Map 16, where it is evident that very high rates of population increase (greater than the national growth rate for the 20-year period) occurred almost entirely in the census subdivisions around the major metropolitan areas and in some of the smaller urban agglomerations such as Sherbrooke and Kingston (with growth in post-secondary education employment) and Sarnia (expansion of refining or petro-chemical facilities using recently discovered western oil). The shift to the suburbs is matched by much lower growth rates in the densely-populated inner cities of Toronto and Montréal.

The outcome of this massive urban development is the emergence of a fairly contiguous macro-urban region extending from Windsor to Québec City. Not only have the urban areas around Montréal and Toronto coalesced, but the whole area between has become one long, highly-integrated urban corridor in terms of both the flow of goods, people, and information and physical contiguity. Urban areas have merged into each other in some sections, and the establishment of a limited-access highway system has extended commuting fields and permitted the decentralization of a number of different types of economic activities (Massicotte, 1983). Although the general east-west spread of the corridor along the traditional line of transport arteries is the dominant feature, a significant extension to Barrie and Orillia north of Toronto and, to a lesser extent, into the Laurentians north of Montréal has also emerged.

Urban Growth in the Period of Deconcentration

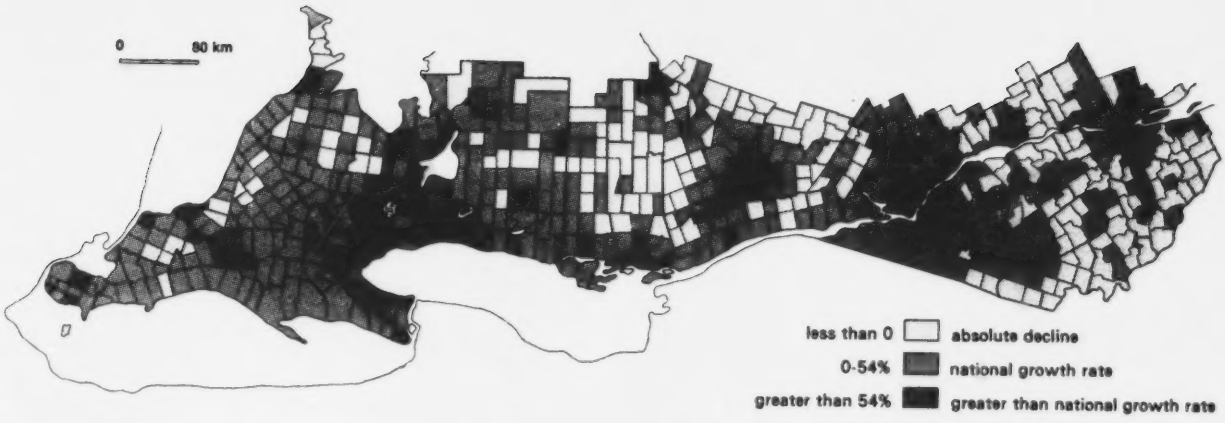
Since 1971, there has been not only a deconcentration of population and economic activities away from the axis, but increased evidence of a number of trends that were present in the 1960s. These trends are partially the

Table 16

The Population Concentration (000s) Within Four Major Urban Regions During the Period of Concentration, 1951-1971

Metropolitan Region	1951		1961		1971	
	Population	% in Axis	Population	% in Axis	Population	% in Axis
Montréal (within 65 km)	1,840	25.3	2,591	26.6	3,174	26.6
Toronto (within 65 km)	1,696	23.3	2,532	26.1	3,413	28.6
Ottawa-Hull (within 25 km)	305	4.2	447	4.6	586	4.9
Québec City (within 25 km)	321	4.4	402	4.1	507	4.3
% within 4 metropolises		57.2		61.4		64.4

Map 16
Population Change, 1951-1971



Map 17
Population Change, 1971-1981

result of: (1) the slow-down in the rate of natural population increase, which has contributed to the impact of inter-provincial and inter-urban migration and immigration; and (2) economic events, which have affected differential urban growth, as well as population changes within metropolitan regions.

One continuing trend is an increase in population located in census subdivisions defined as urban, along with a population decrease in areas defined as rural and sparsely-populated (*see* Figure 7). The general pattern of overall growth and decline is, however, extremely variable, since some extensive areas have an increase greater than that for the nation as a whole and others have had a noticeable population decline (*see* Map 17). There has been a noticeable decline in central city populations in Windsor, Hamilton, Toronto, Ottawa, Montréal, and Québec City, a trend which was already well underway in the 1960s. In fact, if immigration had not continued at a reasonable level for much of the 1970s, the population of these central cities would have decreased even more (Termote, 1978). It should be noted that this decline has taken place despite the recent movement of some people back to the centre of cities, because while some "gentrification" and condominium building has occurred in downtown areas, the redevelopment has invariably been at much lower population densities (Lang, 1982).

Wayne Bond

Some urban dwellers choose to build homes in a more rural setting, largely because of the country atmosphere and relatively low land prices. The cumulative effect of such an urban exodus or deconcentration is the removal of significant amounts of productive land from farming, and a change in the nature of the rural community.

This population decline in the centre of cities has been matched by continuing suburban growth, expansion of the urban fringe, and the repopulation of some areas that had been growing slowly, or even declining, in population in previous decades (Fauteux, 1983; Simmons and Bourne, 1984). This should not be regarded as similar to the recent growth of non-metropolitan areas in the United States (Brown and Beale, 1981), because the entire axis is, by definition, within the sphere of influence of major metropolitan areas. The extensive areas of population increase above the national average observed in Map 17 are related to a continuation of suburbanization and, in some of the more distant places, ex-urbanization (McRae, 1981; Brunet, 1980*b*). Ex-urbanization in this context refers to the movement to smaller towns and villages of people who wish to return to (or create) certain non-metropolitan values. But, whatever the underlying process, the net result is the continuing urban deconcentration in fringe areas affecting agricultural (Lépine and Brunet, 1984) and recreational land.

The population shift toward the four major metropolitan areas begins to level off during the 1970s (*see* Table 17). There are also some noticeable accentuations of the trends of the previous era. First, the population growth within the Toronto area has been quite remarkable, whereas the population growth around Montréal has been considerably less and its share of the axis population has actually decreased. The net result is that by 1981 the area within 65 kilometres of Toronto contained 30% of the population of the axis, or about one out of every six people in the country. This shift has occurred through an acceleration in the 1970s of the trend of office and financial activities moving away from Montréal to Toronto (Szplett, 1983, 1984; Semple and Green, 1983) and the greater strength of manufacturing in the Toronto area. Ottawa-Hull has also noticeably increased its share of the axis population, probably as a result of the increase in federal government and high-technology manufacturing employment during the decade. Interestingly, the expansion of provincial government employment in Québec City has resulted in that area gaining comparatively in population as well.

There have been two types of general population and economic change occurring at three different geographic levels (Bourne, 1984). At the core/periphery level, there has been some deconcentration of population and economic activities. At the axis level, there has been a concentration toward Toronto and southwestern Ontario in general; and, at the metropolitan level, there has been a continuing general deconcentration into areas some distance away from the traditional city core.

CONCLUSION

There have been distinct periods of urban development within the axis area, with different effects on a variety of concerns related to such public policy matters as housing provision, the high price of land for housing around some metropolitan areas, urban and inter-urban transport, and the provision of local services and physical infrastructure. The important feature, however, is that these concerns arose primarily as a result of particular

Table 17

The Population Concentration (000s) Within Four Major Urban Regions During the Period of Deconcentration, 1971-1981

Metropolitan Region	1971		1981		Area	
	Population	% in Axis	Population	% in Axis	km²	% in Axis
Montréal (within 65 km)	3,174	26.6	3,350	25.4	11,938	6.8
Toronto (within 65 km)	3,413	28.6	3,935	29.8	7,563	4.3
Ottawa-Hull (within 25 km)	586	4.9	680	5.2	1,965	1.1
Québec City (within 25 km)	507	4.3	580	4.4	1,847	1.1
% within 4 metropolises		64.4		64.8		13.3

urban developments that occurred in the 1951-1971 period. The more recent era is yielding some similar, but other quite different, policy questions, one of which relates to the consumption of land for urban purposes.

A comparison of Maps 3, 14, and 17 indicates that, although general urban growth has diminished, population deconcentration within metropolitan areas is continuing at an escalating rate, and much of this growth is occurring in the one part of the axis (southwestern Ontario) that has the best land for agriculture in the country. It is necessary to examine the bases of these trends in greater detail, because some trends differ from those in the previous period and may be temporary aberrations. On the other hand, the bases of some of these trends might be strong enough to suggest the kind of urban growth, and hence consumption of rural land, that may occur in the future.

G ADVANCE WRECKING ADVANCE

THE BASES OF CHANGE WITHIN THE AXIS

During the past 10 or 15 years, there have been dramatic changes in the patterns of urban development both between the core and the periphery and within the core itself. The deconcentration of population and economic activities at the national (core/periphery) level contrasts with the concentration (to southwestern Ontario) occurring within the axis; this, in turn, contrasts with the continuing deconcentration of population (suburbanization and ex-urbanization) and economic activities (decentralization) occurring within major metropolitan areas. Of course, each of these general trends has embedded within it certain countervailing forces, such as the recent return of some previous inhabitants of central Canada from the west back to the core. These countervailing forces, however, do not predominate over the general trends, though they may do so in the future.

In general, though, it is clear that whereas in the 1960s there was an assumption of continuous growth within a system of urban areas, this assumption is no longer tenable in the face of declining rates of natural increase and the continuous spreading of the population beyond metropolitan boundaries. This slow down, and decline in some cases, of urban development has led to a notion of "the life cycle of systems of cities" (Klaassen, *et al.*, 1981)—that is, variable growth rates in the early stages of urban development, followed by reasonably high levels of growth among all cities, then a slowing down in the overall rate of growth and greater variability in rates of change, and finally very low rates of overall growth and decline in some instances. Although it is not yet possible to produce an overall theory of urban system development, some models and processes that give rise to the described patterns of growth can be outlined and related to urban development.

The models and/or processes to be discussed are those that appear to behave in a cyclical manner, or involve a transition from one state to another in an evolutionary sequence. The general approach is that suggested by Alonso (1980), though the actual models and/or processes involved in this discussion differ in some instances from those proposed by him. These processes (or concepts) are highly interactive with each other, and the objective is to relate them to recent urban developments and population change within the axis. Five general models and/or processes may be considered: (1) sequence of development; (2) cycles of capital accumulation; (3) demographic transition; (4) labour force transition; and (5) product life cycles.

◀ S.S.C. – Photo Centre Library – A.S.C. (73-80)

THE SEQUENCE OF DEVELOPMENT

A general proposition concerning the development of a nation envisages (1) a period of slow growth followed by (2) fairly rapid growth, which eventually gives way to (3) a period of slower rates of increase in material output. This "bell-shaped" pattern of growth rates over time has occurred in many nations and has led to a number of theories of economic development. Rostow (1960) breaks down the developmental history of national economies into five stages that appear to be common to all societies: the "traditional society", establishing the "preconditions for take-off", the "take-off", the "drive to maturity", and the "age of high mass consumption". Although these stages appear to describe some of the essential stages in a development sequence, the model does not analyse causes and indicate how a nation gets from one stage to the next.

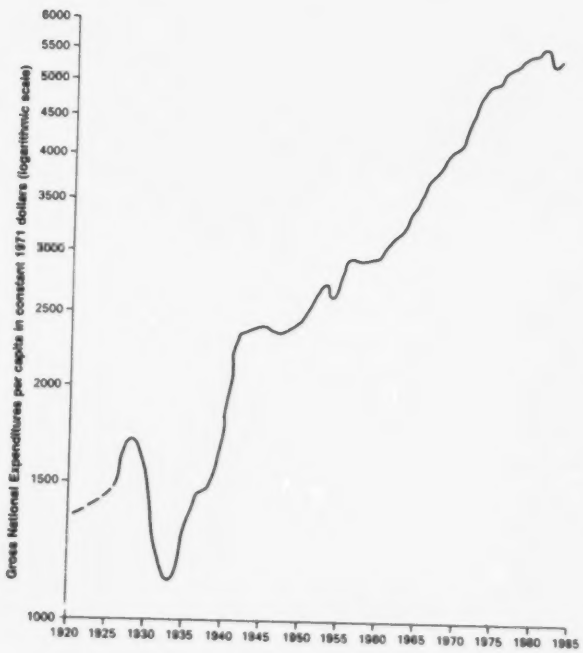
The essential feature of this type of sequence, in terms of population growth and urban development, is that a period of rapid growth in both production and consumption appears to be followed by an inevitable slowing down, since sustaining a moderate level of expansion over a long period of time appears to be extremely difficult. High rates of urban growth will therefore occur during the period of rapid growth in production and consumption, and low rates of urban growth will be experienced at the end of the developmental sequence. The question that arises, of course, is where is Canada now in this sequence?

Sitwell and Seifried (1984) examine economic development in Canada in the context of Rostow's stages of growth. They categorize the period before 1890 as one of establishing the preconditions, the "take-off" occurs between 1896 and 1914, the drive to maturity commences in the 1920s, and the age of high mass consumption emerges after the Second World War. The massive expansion of urban areas and metropolitanization occurred during the last stage, when generally high per capita incomes have permitted a large proportion of the population to make consumer purchases above the bare essentials.

One clue with respect to the possible future course of urban development is that economic growth and increasing wealth permit individuals to purchase more urban infrastructure (housing, roads, commercial facili-

ties, and so forth) and quasi-urban benefits (such as second homes and ex-urban life-styles). A measure of the trend in per capita wealth is presented in Figure 8, which plots the change in gross national expenditures (GNE) per capita from 1926 to 1983 (in constant 1971 dollars). The data include personal and governmental expenditures on goods and services and gross fixed capital formation. Public and private purchase of urban infrastructure and consumer goods was simply not possible for most people until after 1950, since most of the period from 1930 to 1950 was concerned with the depression of the 1930s and the war effort. Apart from some minor recessions in the 1950s, wealth increased at a high rate through to 1973, after which time the rate of growth decreased considerably.

Figure 8
Increase in Gross National Expenditures (GNE) Per Capita, 1926-1983



Sources: Leacy, 1983, and Statistics Canada, Cat. No. 13-201.

Unfortunately, it is not possible to disaggregate the information in Figure 8 for an estimate of changes in material wealth in the core compared with the periphery. However, the growth rate in GNE/capita (the surrogate for material wealth) for the core between 1950 and 1973 was probably somewhat higher than the national average, while that for the periphery was somewhat lower. This was reversed over the past decade, when the GNE/capita has probably been higher for the periphery than for the core. This trend may have, in turn, been reversed during the recent recession of the early 1980s and subsequent slow recovery. While average national increases in material wealth in the periphery stimulated greater urban growth (and deconcentration) in that part of the country during the 1970s, the situation may well be reversed again during the 1980s.

The general rate of urban growth during the 1980s will undoubtedly be lower than during the 1970s and a great deal less than in the 1951-1971 period. The country may now be in a period of slow growth in material output at the tail end of the developmental sequence. Consequently, predictions are that there will be very low rates of increase in material wealth per capita over the next few years, and a number of short recessions will be followed by recoveries. If that is the case, there will not be much wealth available in either public or private purses to stimulate large investments in urban and urban-serving infrastructure within the axis, and economic development will not be as strong a stimulus for urban expansion and rural-to-urban land conversion as it was in the 1951-1971 period.

CYCLES OF CAPITAL ACCUMULATION

Figure 8 demonstrates not only the general variation in rates of increase in material wealth (or GNE/capita) over the past few decades, but also the presence of a number of economic fluctuations (or cycles) of various intensities. These cycles have a similar internal sequence, but they vary in length, and there may be cycles within cycles. Economic cycles have a considerable effect on the periodicity and general rate of investments in urban infrastructure, so it is useful to indicate what they are and their possible causes.

The bottom of a cycle is the *trough*, where unemployment is high, the rate of return on investments low, and there is much unused industrial capacity (Lipsey, 1983). This is followed by a period of *expansion*, when the rate of unemployment decreases and incomes, consumer spending, and business investments all increase. The *peak* of the cycle occurs when there is a high use of industrial capacity and labour, and the rate of return on investments begins to level off. As the rate of increase in economic output begins to decelerate and the rate of return on investment decreases, a contraction may occur which leads to a *recession*. When demand and production decrease, the recession may intensify into a deep trough (or depression) if a crisis in confidence occurs (as it did in the late 1880s and 1930s). These cycles are not symmetrical, with the period of expansion

and the peak usually being the longest part of the cycle (Marr and Paterson, 1980).

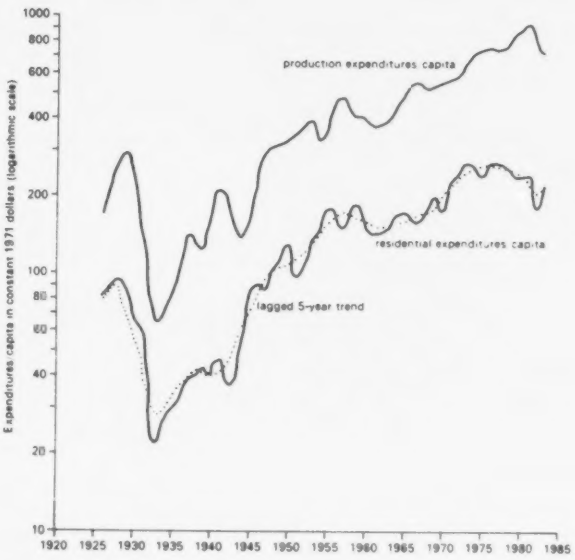
The major causes of these fluctuations appear to be: (1) changes in investment in productive capital stock and inventories, which are influenced by interest rates and expectations concerning profits; (2) variations in trade; (3) government purchases, which currently comprise about 20% of gross national expenditures; (4) demographic changes in the population, influenced by economic and political factors (immigration) and other primarily social factors (rates of natural increase); and (5) major periods of innovation and/or expansion into new resource frontiers and discoveries of raw materials (staples).

It has been suggested that these various processes give rise to three different types of fluctuations or cycles within cycles: (a) Short *inventory cycles* of one-to-three years duration, which are related to the immediate adjustments to actual and short-term fluctuations in sales made by business. (b) *Business cycles*, of about four-to-nine years, caused by variations in capital investments by business in response to perceived and expected changes in rates of return (profit) to capital investments. In this context, between 1953 and 1982, there have been four cycles with an average length of seven years (*see* Figure 9—production expenditures graph). (c) *Long swings* or *long waves*, which Kondratieff (1935) has defined as being of 40-60 years duration and Kuznets (1961) as being about 20 years. The Kuznets swings seem to be embedded within the Kondratieff long waves. Rostow (1975) relates these long-term trends to the interplay of: (i) the life cycle of major product and technological innovations which gives rise to periods of growth and decline in leading sectors of economic activity (Rothwell, 1982); (ii) fluctuations in the supply and demand for foodstuffs, raw materials, and energy; and (iii) changes in population, household formation rates, and the size of the working force.

Investment in urban infrastructure and the consequent rate of urban growth and expansion are strongly related to business cycles and long swings. General investments and building activity tend to be greatest at the peak of, or shortly after, business cycles and long swings. For example, in Figure 9, many (but not all) of the peaks in per capita expenditures on residential construction occur shortly after peaks of business investments in productive capital stock (machinery and equipment, and non-residential construction). These short-term fluctuations in residential construction level off to reveal longer-term waves of between 20 and 25 years duration, which is why Kuznets swings are often referred to as building cycles. For example, one smoothed peak in the residential construction cycle in the mid-1950s is followed by another, somewhat higher, peak in the mid-1970s.

Figure 9

Increase in Per Capita Expenditures on Production Capital (Gross Fixed Capital in Machinery and Equipment, and Non-Residential Construction), and Residential Fixed Capital, 1926-1983



Sources: Leacy, 1983, and Statistics Canada, Cat. No. 13-201.

The elements to be considered in estimating future rural-to-urban land-consumption rates are the short-term trends in the business cycle and the longer-term nature of the building cycle. Technological and demographic factors affecting the long waves and the building cycle are particularly important, and some aspects of these influences will be considered in ensuing sections. If the building cycle is viewed as a phenomenon in itself, then we are clearly heading toward a trough which should be reached by about the mid-1980s. The interesting question relates to the speed of the transition to a new phase of expansion. The general discussion of economic growth in the previous section leads to the conclusion that the rate of recovery will not be swift, and that the trough may be comparatively deeper and considerably longer than that experienced in the early 1960s. The nature of the building cycle does, however, suggest that an expansionary phase may be attained by the end of the 1980s, and at that time pressures for rural-to-urban land conversion may reach a new level of intensity.

THE DEMOGRAPHIC TRANSITION

Although the interrelationship between population growth and economic development is to a degree recursive, one of the influences on long-term cycles arises from demographic changes in the population. These changes can be analysed in terms of (1) the traditional demographic transition model, (2) domestic migration, which can be examined in terms of its rural-to-urban components and inter-urban flows, and (3) fluctuations in levels of in-migration and the destination of immigrants. The general proposition is that fluctuations in each of these components influence the level of urban development, particularly within the core region of the nation's economy.

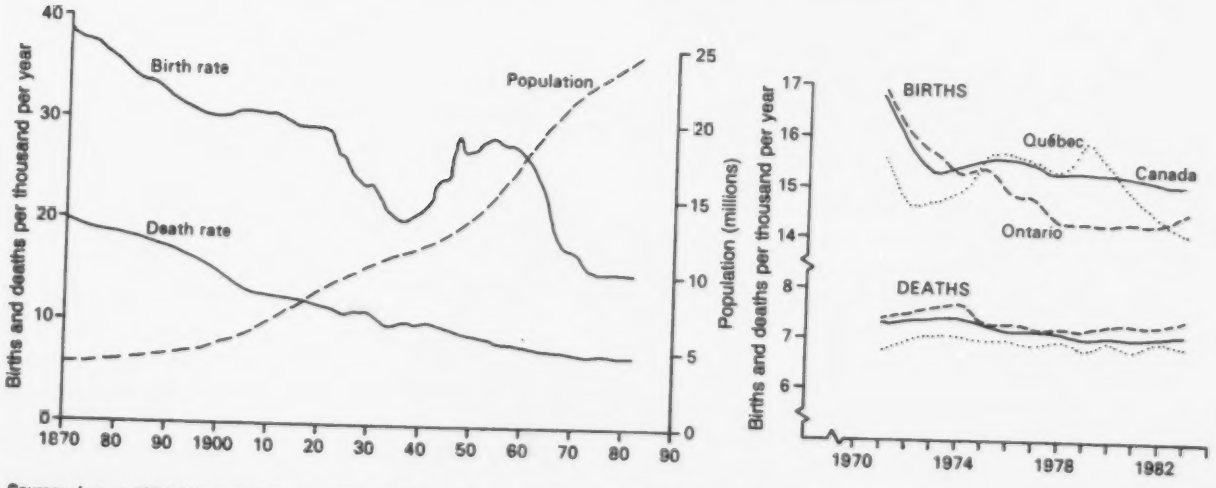
The Demographic Transition Model

The traditional demographic transition model deals with the way in which changes in fertility and death rates interact to give rise to a cycle of population growth within a nation. At an early stage, when the level of economic development and food production is quite low, high birth rates are counterbalanced by high death rates to generate a fairly stable population. Following this is a second stage, when death rates begin to diminish (due primarily to improvements in the availability of food), and with continuing high birth rates the total population begins to increase quite rapidly. A decline in birth rates heralds the onset of a third stage, for while the population is still increasing as a result of the fertility/death rate gap, the gap is also diminishing and the growth rate of the population begins to diminish also. Decreases in fertility are usually associated with industrialization, urbanization of the population, increases in general wealth, and great improvements in agricultural productivity. The final stage of the model is again one of low total population growth rates, because in this period death and birth rates are roughly similar and are moving in the same direction.

Although the general form of the model is reasonably uncontroversial, there is considerable debate in the literature about the inevitability of the sequence (which is based primarily on the experience of countries in Western Europe and North America) and the factors contributing to changes in fertility and death rates. The data presented in Figure 10 suggest that Canada moved from the third (or late expansionary) phase to the fourth phase of low birth and death rates after 1920, though the economic depression of the 1930s and post-Second World War "catching-up" period caused immense fluctuations in birth rates.

In Figure 10, crude birth rates (i.e., live births per 1,000 population) are used as a surrogate for fertility rates, which are influenced (as are death rates) by the age profile of the general population and levels of immigration. For example, a "young" population will have higher birth rates than an older population, and a population with a high level of net immigration will also tend to have higher birth rates because most immigrants are of child-rearing age. The gross reproduction rate, which measures the average number of daughters born to women of child-bearing age, thus reached a post-1921 peak of 1.87 in 1956 and declined thereafter, remaining below 1.0 since 1972. According to this measure, the popula-

Figure 10
Birth Rates and Death Rates in Canada, 1870-1982



Sources: Leacy, 1983; Marr and Paterson, 1980; and Statistics Canada, Cat. No. 84-001 and 84-202.

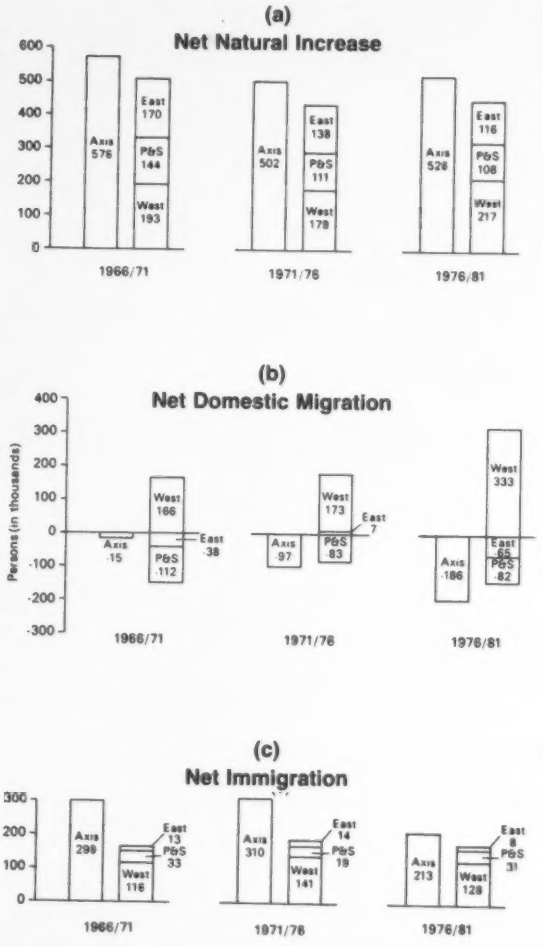
tion has not been replacing itself since 1972, and the growth that has occurred has been because of the relatively young Canadian population, a longer lifespan, and fairly high levels of immigration. With the aging of the Canadian population, there will clearly be a considerable decrease in the crude birth rate over the next few decades.

While there was considerable regional variation in birth and death rates up to 1951, the rates have converged since that time (Kalbach and McVey, 1979) and there is now little difference between the core and periphery. The inset diagram to Figure 10 demonstrates that axis birth rates (as defined by the data for Ontario and Québec) are generally less than those for Canada as a whole, while the death rates are quite similar, being slightly higher for Ontario but lower for Québec. The net natural increase (births-deaths per 1,000) for both the core and the periphery is therefore quite low, and the gross reproduction rates indicate that no part of the country is reproducing itself from its own population (Termote, 1984). However, the relatively large number of people of child-rearing age and the increasing lifespan of the average person mean there is a positive net national increase in both the core and the periphery.

Figure 11 has been prepared from information for the provinces, with the axis data estimated from a proration based on population for each time interval. The east is defined as the Maritime Provinces (with Newfoundland) and the non-axis portion of Québec. The Prairies and Shield (P&S) is defined as Manitoba and Saskatchewan with the non-axis portion of Ontario, and the west includes Alberta and British Columbia. The net natural increase estimates in Figure 11*a* indicate that the axis share of the total net national increase is about the same as its share of the total population for each of the three time periods. It is interesting to note that the west's share has increased considerably, undoubtedly because of high rates of domestic and foreign migration to this area in recent years.

Figure 11

Components of Demographic Change, 1966-1971, 1971-1976, and 1976-1981



Modified from Termote, 1984.

Domestic Migration

One of the chief sources of differential urban growth used to be rural/urban migration. For the past few decades, however, most of Canada's population has been residing in urban areas, so the primary sources of differential urban growth have become differences in natural increase, changes in the direction of domestic inter-provincial and inter-urban migration, and the net destination of foreign immigration. Since birth and death rates in different parts of the country are generally similar (Kalbach and McVey, 1979), with existing variations related to the way in which migration affects population age profiles (Keyfitz and Philipov, 1981), migration has a considerable effect on differential growth.

Recent changes in domestic (i.e., internal) migration patterns with respect to the core and the periphery have been quite dramatic (*see* Figure 11*b*). During the 1950s, the axis gained population as a result of internal migration; in the 1960s, gains and losses from migration were almost in balance (with the Ontario portion of the axis gaining and the Québec portion losing), but, in the 1970s, the axis lost population equivalent to that of a middle-sized metropolis. Furthermore, during the 1970s, both the Ontario and Québec portions of the axis were net losers in domestic migration, though Québec lost 50% more than Ontario during the latter half of the period.

Although the argument concerning the relative strength of "push" and "pull" factors in migration, along with their

various causes, continues unabated (Simmons, 1982), there are some fairly distinct macro-level economic, social, and cultural factors that may be influencing the changes in Figure 11*b*. First of all, the life-style attractions of the west were enhanced by job opportunities generated by the boom in exploration and development of oil and natural gas there during the latter half of the 1970s (Economic Council of Canada, 1984). Although that particular boom has abated, there remains a strong underlying trend westwards. The Prairies/Shield area has incurred depopulation through migration from farms and service and mining towns (Polèse, 1981*a*) during the 15 years covered by the data. The east, on the other hand, has experienced some fluctuation, with net out-migration being reversed briefly in the 1971-1976 period, possibly due to the social preferences of older return migrants and the relative economic prosperity of the area. The unusually large volume of out-migration from Québec, which swelled the axis figures in 1976-1981, was undoubtedly influenced in part by the separatist mood at that time (Cartwright, 1980).

Courtesy of Parkway Van Lines, Ottawa

A complex array of financial, employment, cultural, and amenity influences affect internal migration patterns. Push factors such as a factory closure are quite strong, while pull factors, including family ties, improved job prospects, or a moderate climate, also exert persuasive powers. In the late 1970s, the oil and gas boom in western Canada and the uncertain political situation in Québec both had a major influence on domestic migration.

Many different and countervailing forces in a particular period therefore influence the pattern of domestic migration. Although economic factors undoubtedly play a role, they often appear not to be as strong an influence as social, cultural, and amenity considerations (Termote and Frechette, 1980). An interesting phenomenon concerns the startling reversals in net flows at the macro-core/periphery level over the past 15 years; these fluctuations can incur considerable social costs for both the individuals and communities involved (Tepperman, 1983). Recent information suggests that the drift to the west during the 1980s may be diminishing to the level of the 1966-1971 period and that out-migration from the axis is now sharply reduced. However, the west will continue to gain population from all other parts of the country, though the volumes will be closer to those of the early 1970s.

Foreign Immigration

The previous chapter noted the important role of international migration in the population growth of the country. Since 1951, between one-fifth and one-quarter of Canada's increase in population has been directly accounted for by net foreign immigration, and because a large proportion of immigrants are of early child-rearing age, this group has also strongly affected birth rates (and have diminished the death rate). The destination of immigrants can therefore play a vital role in establishing patterns of differential population growth.

One of the chief difficulties with analysing the effect of immigration on population change is that, while reasonably good information is available about the destination of immigrants (and the countries from which they come), comparable information is not available for those leaving the country. Estimates of emigration are usually obtained by using counts from the United States and the United Kingdom of immigration (or returnees) to those countries from Canada, and then prorating these numbers by some factor to arrive at an overall out-migration figure. A second way of obtaining net international migration figures is to calculate them as a residual. This is the method used to derive the data for Figure 11*c*.

The residual method is based on a simple demographic accounting model which can be written as follows:

$$P_i^t = P_i^{t-l} + (B - D)_i^{t-l,t} + (DI_{ji} - DO_{ij})^{t-l,t} + (FI_{,i} - FO_{i,})^{t-l,t}$$

The population in area *i* (for example, the axis) at time period *t* (say, 1981) is equal to the population at some earlier time period *t-l* (say, 1976); plus the number of births minus deaths that have occurred in the area between *t-l* and *t* (the net natural increase); plus the number of domestic immigrants (DI) from *j* other parts of Canada to *i*, less the number of domestic out-migrants (DO) from *i* to the *j* other parts of the country in the time period (the net domestic migration); plus the number of foreign immigrants (FI) to *i*, less the number of people who have left *i* for foreign parts (FO) during the time period (the net international migration). If there are reasonably accurate census counts for an area for P^t_i and P^{t-l}_i, net natural increase, and net domestic increase, then net international migration can be derived from the residual number.

The volume of foreign immigration in any year is influenced by policies of the Ministry of Employment and Immigration, which attempts to control the rate of annual

S.S.C. – Photo Centre Library – A.S.C. (80-304)

Largely because of employment opportunities and existing ethnic communities, many immigrants favoured large metropolitan cities such as Montréal and Toronto. CHIN Radio/TV International in Toronto began broadcasting in 1966 during a period of heavy foreign immigration. It is indeed multicultural radio, airing programs in 32 languages and sponsoring numerous ethnic community events. Serving much of southern Ontario, the station estimates Italian listeners alone at 500,000.

in-flow according to domestic labour requirements (Polèse, 1978). The rate of annual out-flow appears to fluctuate far less than in-flow and averaged about 70,000 persons per year during the 1970s. The volume of net international migration has decreased during the latter part of the 1970s, largely as a result of rising unemployment rates in the domestic economy (*see* Figure 11*c*).

The interesting feature is that, while the axis was clearly the favoured destination of most immigrants up to 1976, the periphery began to gain almost as many immigrants as the core after 1976. It is also evident that, up to 1976, foreign immigration to the axis more than offset the net loss due to domestic migration, but in the latter half of the decade, the two flows are almost in balance. Given the likelihood of fairly high rates of unemployment continuing into the future, the volume of foreign immigration in the 1980s will likely be much less than what prevailed in the 1970s. However, as unemployment eases in the 1990s, with a large reduction in the number of new labour force entrants, foreign immigration may then be encouraged and the net in-flow may return to the level experienced in the 1970s.

Total Migration Within the Axis

With the decline in, and comparative stability of, birth and death rates and the relative decrease in net natural population increases, differential growth is now more influenced by migration patterns (Simmons, 1983*a*). The patterns of net migration therefore provide another reasonably good indicator of areas of possible urban pressure on land. Urban areas with high levels of positive net migration will be those in which future urban expansion, and therefore the urban consumption of rural land, may well be the greatest if current migration patterns persist.

Unfortunately, it has been possible to estimate migration for census divisions only, and the migration figures relate to net domestic *and* foreign migration calculated as a residual, when the natural increase is subtracted from the total population increase for each county. Since births and deaths for each county have been compiled from annual statistics, the net natural increase may well be overestimated in some cases, because a birth in one year could become a migrant in a subsequent year.

Information for the axis is presented on Map 18, where the net migration figures are expressed as a percentage of the 1981 population in the county and aggregated to five class intervals. Between 1971 and 1981, large areas of both the east and west portions of the axis have lost population as a result of migration, while a considerable part of the central area has actually gained population. Both Metro Toronto and Île de Montréal have also lost population through migration, while the counties immediately surrounding them have made large or extremely large gains. There have also been larger gains in some rural and sparsely-populated counties that have experienced ex-urban growth (e.g., Haliburton and Montcalm) and/or a particular economic stimulation (e.g., construction of the large nuclear power station in Bruce County).

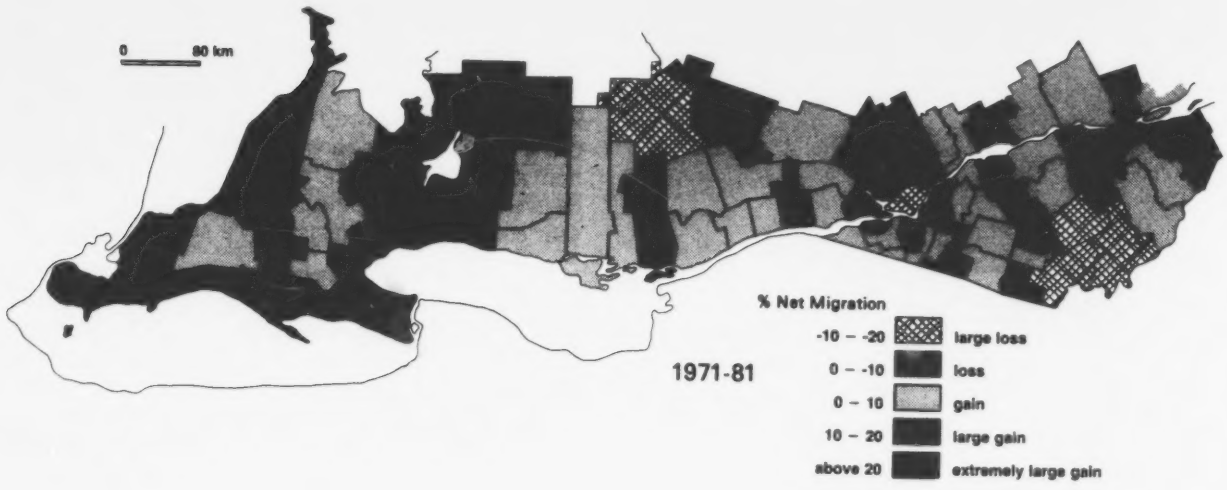
The dominant feature, however, is that the areas defined as urban in 1981 (*see* Map 14) with large and extremely large gains from in-migration are confined primarily to the counties immediately adjacent to Toronto and Montréal, and secondarily to the west of Hull and south of Québec City. High levels of net migration will probably create particular pressures on rural land in Halton, Peel, York, and Durham counties in Ontario and in LaPrairie, Verchères, L'Assomption, Chambly, Soulanges, Vaudreuil, Deux Montagnes, and the southern part of Terrebonne in Québec. The impact of economic growth in and around these major metropolitan areas does not extend far into southeastern Ontario or to the south and west of Montréal.

While the processes affecting these net migration rates are quite complex, there appears to be a combination of push and pull factors working together to influence the patterns in Map 18.

Push factors are generally considered in the literature to have the greatest influence (Greenwood, 1981), because migrants do not usually know that much about the economic, social, or political situation in other areas and they respond more to the negative aspects about the place in which they currently reside. Unemployment can be regarded as a surrogate for the push factor; Map

Map 18

Increase or Decrease in Net Migration as a Percentage of the 1981 Population, by Census Division, 1971-1981



Sources: Statistics Canada, Cat. No. 84-204, 84-206, 84-207, 84-542, 92-719, 92-828, 92-907, and special tabulations.

19 presents 1981 unemployment rates for the total labour force (*see* Map 19*a*) and the labour force in the 15-24 age group (*see* Map 19*b*). The estimates used in Map 19*a* are based on the unemployed population and the recorded labour force at the time of the census. The 15-24 age subset is modified by the normal labour force participation rates exhibited by males and females in the group.

On the basis of these extensive calculations, the unemployment rate for the axis is estimated in 1981 (at the date of the June Census) to be 7.12%, compared with a non-axis rate of 7.64% (the Statistics Canada *Labour Force Survey* estimate for 1981 is 7.6% for the country as a whole). For young people (the 15-24 age subset), the rate is much higher at 13.12% for the axis as a whole, with a slightly higher estimate for the rest of the nation. Since the level of unemployment appears to be higher for the Québec portion of the axis (9.78% for the total, and 17.9% for young people), and lower in the axis part of Ontario (5.41% for the total, and 9.78% for young people), these and the axis-wide averages are used as benchmarks in the maps. Much higher unemployment rates in the eastern than in the western part of the axis are quite evident.

It is generally difficult to find satisfactory measures to serve as surrogates for the pull factor. This is because the in-flow generally contributes toward the variable being used. This is undoubtedly the case here since pull is translated as economic opportunity, and areas that have high economic opportunity are considered to be those that have high percentage increases in the labour force. Because the size of the labour force is also related to age and sex participation rates, natural increase, and suburbanization in highly urbanized areas, the measure is regarded as a reasonable indicator of economic health.

The model is:

$$(\%\ \text{net mig. } 71/81)_i = f(\text{unemp. rate } 1981;\ \%\ \text{change in lab.force } 71/81)_i$$

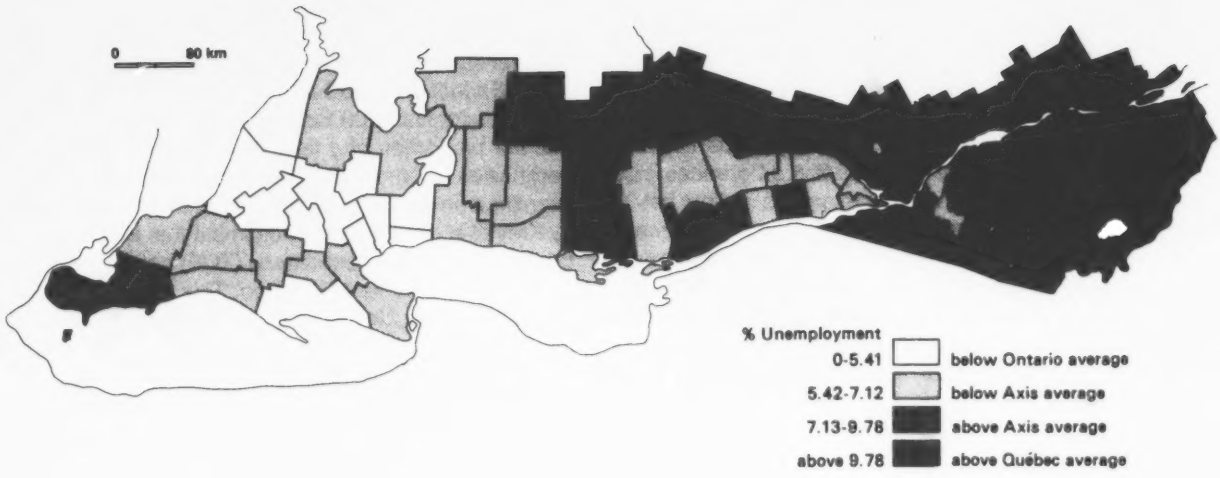
with *i* representing the 1 to 95 counties in the axis. After some experimentation, a linear estimation is regarded as most appropriate. Furthermore, there appears to be no difference in the explanatory power of an equation using unemployment for young people rather than total unemployment, so total unemployment rates are used. The estimated equation is:

$$\%\ NM_i = 1.69 - 1.35\ (UR)_i + 0.23\ (\%\ LF)_i$$

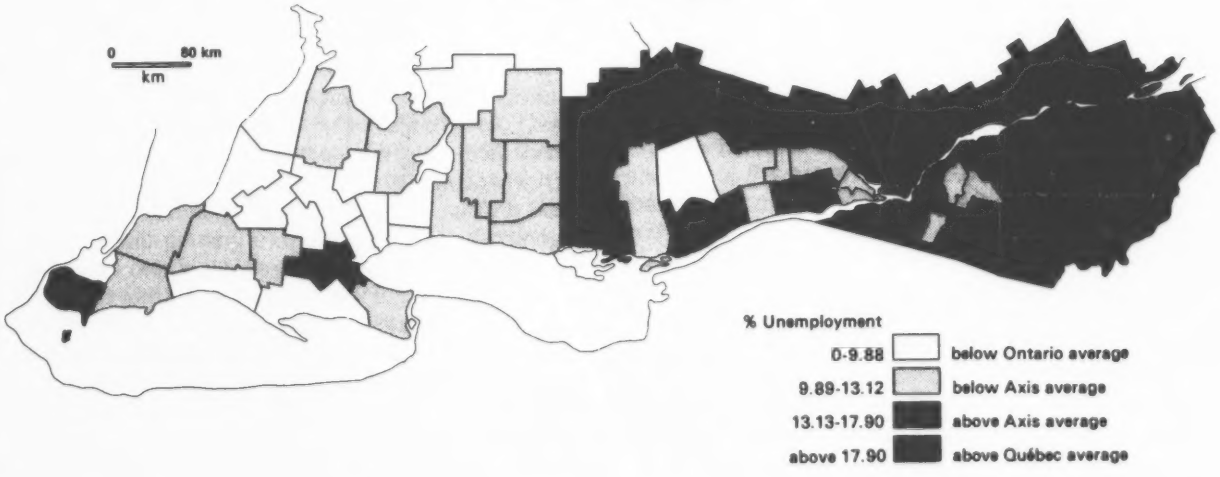
Since the multiple coefficient of determination (R^2) is 74%, the coefficients for the independent variables highly significant, the independent variables almost completely uncorrelated, and the residuals (errors) distributed almost normally (though exhibiting some spatial contiguity), the results can be regarded as reasonably useful. The sign and the magnitude of the coefficient

Map 19
Unemployment Rates, 1981

(a) Total Population



(b) 15-24 Year Old Group



Sources: Statistics Canada, Cat. No. 93-941 and 93-942.

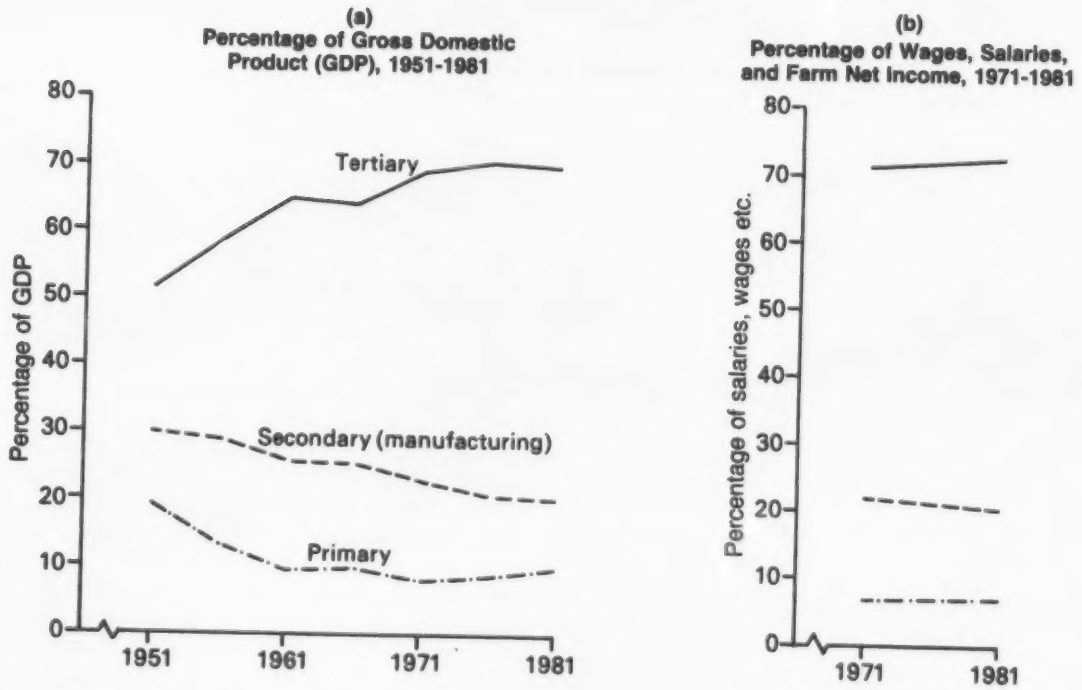
(−1.35) relating to unemployment indicates that net migration is high in areas of low unemployment, but low or negative in counties with high unemployment. On the other hand, the sign for the coefficient (+0.23), pertaining to the second independent variable, indicates that percentage net migration increases directly with the percentage increase in labour force in a county.

Because net figures are used, it is difficult to attribute the surrogate push and pull factors directly to particular geographic areas. Nevertheless, the differences in migration within the axis appear related to distinct patterns of unemployment rates and labour force increases. The axis is demonstrated as being constituted of a number of different and distinct areas of growth, stagnation, and even decline. The pressure of urban growth on land is therefore spatially specific, being related to variations in the economic health of the different parts of the area.

THE TRANSITION TO A SERVICE SOCIETY

One of the major changes that has taken place in Canadian society involves the growth of employment in the service or tertiary sector of the economy. In 1857, Ernst Engel published a study on the conditions of production and consumption in the Kingdom of Saxony. In that study, Engel formulated an empirical generality, based on the budgets of 200 Belgian labourers, which states that the proportion of a family's income spent on food declines as income rises. This observation has been re-examined on a number of occasions, and most recently by Kravis, *et al.* (1982), who estimate that about 16% of total consumption expenditures (TCE) per capita in the United States are spent on food. This figure compares with 23% in the United Kingdom, which has approximately two-thirds of the TCE/capita of the United States. Thus, as income per capita increases in a country, a greater budget share is spent on non-food items.

Figure 12
The Emerging Service Society



Note: Tertiary activities include: construction, transportation, storage; communications; electric power, etc.: wholesale and retail trade; finance, insurance and real estate; public administration and defence; and community, business, and personal services.

Source: Statistics Canada, Cat. No. 13-201.

Table 18

Estimated Primary, Secondary, and Tertiary Labour Force (000s), by Sex, in the Axis for 1971 and 1981

	1971			1981		
	Total	Male	Female	Total	Male	Female
Primary	302	248	54	320	262	58
Secondary	1,321	989	332	1,612	1,162	450
Tertiary	3,454	2,114	1,340	4,822	2,633	2,189
Total	5,077	3,351	1,726	6,754	4,057	2,697

Sources: Data compiled from *Labour Force, 15 years and over, by Industry Type, by Census Subdivision, by Residence, 1981*, Microfiche CTE 81B35, and a special tabulation for 1971 (6591-PO1826-2B-1971) by census division. The tertiary employment category includes the same groups as those used in Figure 12, but differs from those in Table 3 because construction is included. Miscellaneous employment has been allocated between sectors on a prorated basis.

Figure 8 demonstrated that GNE/capita in Canada (in constant dollars) has more than doubled since 1950. A large part of this increase in general wealth has been devoted to the purchase of manufactured products and higher levels of services. In fact, it may be postulated that once a certain level of consumption has been achieved in food and manufactured products, a greater share of a family's budget is devoted toward such tertiary services as health care, education, shopping facilities, entertainment, and other recreational activities. Over the past few decades, and particularly since 1950, there has been a gradual transition from a situation in which a large part of the employment and economic activity was associated with primary and secondary (manufacturing) activites, to one in which a great deal of the wealth is associated with the tertiary sector of society. The impact of this trend on urban growth is extremely important because service activities are generally urban-located and distributed in a hierarchical manner, with the largest urban centres being dominant (*see* Map 8). For example, Montréal so dominates the Eastern Townships that even Sherbrooke, which is 150 kilometres from Montréal, has difficulty in competing in its immediate hinterland with the major metropolis for the provision of certain service activities (Polèse, 1982).

This emergence of a service, or post-industrial, society (Bell, 1976) seems to involve three basic themes: (1) a shift in an economy from one in which the labour force is occupied primarily with manufacturing to one in which service employment predominates; (2) an increase in the numbers of professional, technical, scientific, and managerial-oriented occupations in society; and (3) an accelerated importance of information processing and control in economic and social activites. One of the many outcomes of these general underlying themes is a reduction in the proportion, and eventually actual number, of people in manufacturing (de-industrialization), and an increase in the proportion and number involved in service activities.

The documentation of this shift to a service society is expressed best in terms of changes in the sector composition of the gross domestic product (GDP), rather than employment which includes individuals employed both full-time and part-time. In Canada, tertiary activities contributed a little more than 50% of the GDP in 1951, but this proportion rose to about 70% during the 1970s (*see* Figure 12*a*). The sector of activity that has grown the most has been community, business, and personal services, which contributed slightly more to the GDP than manufacturing in 1981. Since GDP also includes the value of production of the different sectors, the amount going to wages, salaries, and the net incomes of farmers and owners of unincorporated businesses has been extracted to isolate the "income" component for the 1970s. This information (*see* Figure 12*b*) suggests that the tertiary share of the GDP has increased slightly for the country in the most recent decade.

One most important feature associated with this increase in activity in the service sector is the entry of women into the paid labour force in Canada over past

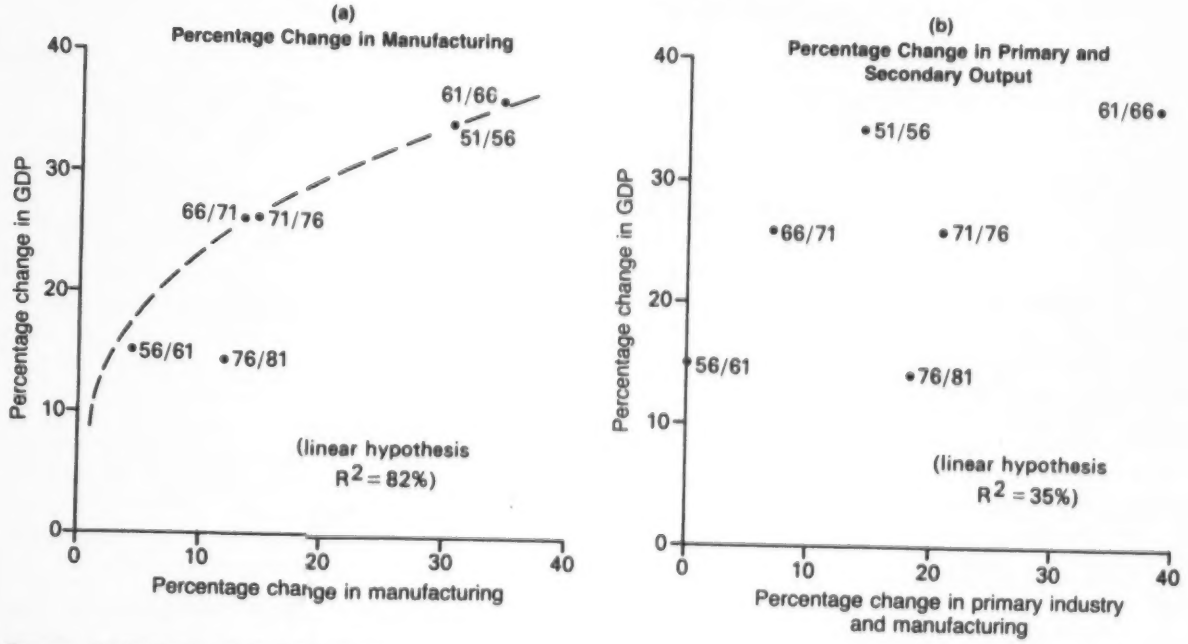
years. The proportion of working-age women employed in the paid labour force increased from 40% to over 50% between 1971 and 1981, and the participation rate in the axis is above 55% (compared with a male participation rate of 80%). Between 1971 and 1981, the axis female labour force has therefore increased at a much greater rate than the male labour force (56% as compared with 21%), and most women are employed in the burgeoning tertiary sector (*see* Table 18). A significant number of these jobs (about one-third) are part-time.

The essential feature of this transition to a service society, which is based on high productivity in the primary and secondary sectors of the economy, is that these employment opportunities are urban and metropolitan-located. Furthermore, the increased number of women in the labour force reinforces this large urban area-metropolitan concentration, because households are now attempting to maximize the joint employment opportunities of more than one person. Since the range of potential employment opportunities for both sexes is greater in the larger urban centres, strong social forces combine with the service transition to concentrate growth in metropolitan areas. These two processes therefore act together to stimulate urban growth and generate pressure on land in larger centres.

PRODUCT CYCLES

Since the axis is the manufacturing heartland of the country, it is important to relate fluctuations in urban growth to product cycles in manufacturing. Several years ago, Kaldor (1966) presented a number of propositions concerning economic growth in a country, and the model has subsequently been the subject of much debate (Thirwall, 1983). The first, and most basic, proposition is that the faster the rate of growth in manufacturing in a country, the faster will be the rate of economic growth (as measured, for example, by gross domestic product). This is not just because manufacturing forms a part of gross domestic product (GDP), but because the wealth generated by high productivity in manufacturing induces economic activity outside the secondary sector (Boisvert, 1978). This relationship for the Canadian economy is presented in Figure 13. While there is a fairly strong, positive association in the constant dollar, five-year growth rates between manufacturing and the GDP between 1951 and 1981 (*see* Figure 13*a*), the association in growth of combined primary and secondary activities and change in GDP is quite weak (*see* Figure 13*b*). Manufacturing appears to have been the engine of growth in the Canadian economy in recent decades.

Figure 13
The Relationship Between Percentage Change in Gross Domestic Product (GDP) and Major Sectors of National Output



Source: Statistics Canada, Cat. No. 13-201.

The health of manufacturing in an area is related to the mix of manufacturing activities and the stage of each in the product cycle (Norton and Rees, 1979). The product-cycle concept associates the early stage in a product's development with innovation, which entails high costs, expensive research staffs, short production runs, experimental marketing, and high research and development costs. The *innovation phase* is replaced by a *growth phase*, after the product has been sufficiently developed and found to have market appeal. The growth phase, which might still require some process innovation (Malecki, 1981), continues for some time until a reasonable market share can be estimated and the manufacturing activity can become standardized. The firm may then begin to realize a small return on its research and development investment.

The standardization of both the product and manufacturing process gives rise to the third, or *mature product*, phase of mass production where there is no further innovation, though there are attempts to improve market penetration. This mature, high profit, phase continues for as long as the product is in demand, or some new innovation involves substitution or product refinement. The last phase is therefore one of *output decline*, decreased market share, and declining profitability. The length of the cycle depends upon the product—firms manufacturing minicomputers and accessories appear to have short cycles, whereas those producing automobile tires have quite long cycles. The length of the cycle is also influenced by the capital investment required to establish the mass-production facility.

The geographical implications of the product cycle are interesting when related to the location of the different elements of the cycle and the spatial division of the work force:

(a) The innovation or new product phase, with highly trained labour involved in research and development activities, tends to take place in large metropolitan areas because of the variety of expertise and information required (Malecki, 1980). Furthermore, in terms of corporate structure, research and development is usually located close to the head office, because it is so vital to the future productivity of the firm.

(b) The growth phase, which still involves considerable attention to manufacturing or process innovation, also occurs close to the research and development activities within the extended metropolitan area.

(c) The mature product phase, in which no research and development occurs, is located where production and marketing costs are minimal. In general, large corporations can afford to distinguish between head office, administrative, research and development, routine financial and accounting matters, and production functions, so mass-production plants are located in areas that minimize labour and other costs (Hekman, 1980) and maximize possibilities for market penetration. The establishment of mass-production facilities may therefore occur in low labour-cost areas where other cost-minimizing advantages, such as regional development grants and capital write-offs, may also be arranged.

(d) In the final phase of the product cycle, the mass-production facility may be closed down, or a new line that has reached the mature product phase may be substituted.

The product-cycle model, and its geographical implications, has particular relevance to the past and future development of manufacturing within the axis and therefore on differential urban growth. Innovation is extremely important for a healthy economy, because this phase contributes to potential future economic activity. One of the problems with Canadian manufacturing is that 45% of it is foreign-controlled, primarily by multinational firms headquartered in the United States. Table 19 documents the extent of foreign control (usually defined as when more than 50% of the voting rights of a company are controlled by foreign concerns) by industry group for the country as a whole, but since most of this activity is located in the axis, the numbers can be regarded as indicative of the core situation.

The discussion of the product-cycle model leads to the conclusion that a large part of the product and growth phases of at least seven major manufacturing sectors occurs outside Canada, and invariably in the United States. The manufacturing plants in the axis in these, and some other, sectors are mainly branch plants of foreign-owned companies that have been located here to gain local market penetration and take advantage of lower wage rates and government incentives. Britton and Gilmour (1978) argue that this foreign-owned, branch-plant nature of the Canadian economy has a negative effect on the balance of trade, reduces the innovative capacity of Canadian industry, and restricts the establishment of domestic inter-industry linkages (Brouillette, 1982). Such an economy also limits the types of employment available for the relatively high-wage jobs in research, development, design, marketing, and other professional activities that are located in the foreign country.

A branch-plant economy has particular weaknesses during the period of decline in the product cycle, or decreasing demand occasioned by a downturn in the economic cycle. Although such avenues as intensification (reducing the length of the working day) or re-

Table 19

Changes in Foreign Control of Manufacturing Industries in Canada, by Industry Group, 1970, 1976, and 1981

Industry Group	1970[1]	1976[1]	1981[2]
Food and Beverages	33.3	34.0	28.2
Tobacco Products	99.5	99.7	98.5
Leather	72.6	67.7	79.0
Textiles	19.9	18.1	25.3
Knitting Mills	18.4	16.7	20.1
Clothing	11.2	12.8	23.0
Wood	25.0	24.6	28.6
Furniture and Fixtures	16.5	14.9	31.1
Paper and Allied Industries	48.3	45.4	34.8
Printing and Publishing	11.9	10.5	11.3
Primary Metals	45.0	23.1	8.4
Metal Fabricating	39.9	40.5	33.5
Machinery	72.3	59.3	66.5
Transport Equipment	87.0	84.6	85.1
Electrical Products	64.6	61.6	52.3
Non-metallic Minerals	51.4	56.2	65.5
Petroleum and Coal Products	97.9	92.3	72.2
Chemicals and Chemical Products	81.6	77.7	60.1
Miscellaneous	54.0	53.5	56.9

Sources: [1]The data for 1970 and 1976 are based on manufacturing shipments in: Statistics Canada, 1981, *Domestic and Foreign Control of Manufacturing, Mining, and Logging Establishments in Canada, 1976*, Cat. No. 31-401.

[2]The information for 1981 is based on capital and repair expenditures in: Statistics Canada, 1983, *Capital Expenditures of Domestic and Foreign-Controlled Establishments in Manufacturing, Mining, and Forestry*, Cat. No. 61-215.

investment and technical change to increase productivity (Massey and Meegan, 1982) may be possible, the most usual response is dis-investment, or closing down the plant (Manzagol, 1983). This last response is most probable because a foreign-owned company does not face the same political (and social) pressure to maintain employment as a domestically-owned concern. Parts of the axis containing foreign-owned branch plants are therefore likely to experience extreme and sudden fluctuations in employment at the tail end of a product cycle, or during a recession.

Changes in manufacturing output and employment resulting from the product cycle could underlie fluctuations in urban growth in different parts of the axis. Areas that depend on a few types of industry, such as the Zone mixte, the extended Cantons de l'Est, and Windsor-Chatham (*see* Map 7), appear to be particularly vulnerable. On the other hand, the manufacturing areas of the Golden Horseshoe, London-Kitchener, and Montréal, which have a diversity of industrial types, are in a better position to absorb the phasing-out stage of particular product sequences. These areas, along with Ottawa-

Hull, are also places where a number of newer information-processing and biotechnology-related industries will probably achieve higher rates of growth in the future. But the generally weak position of axis manufacturing in the major manufacturing sectors, within which new innovations are likely to be translated into employment, is revealed by the fact that the labour force in petroleum and coal products, chemical and chemical products, non-metallics, and electrical products increased by only 16.7% between 1971 and 1981, compared with 26.3% for manufacturing as a whole. The axis is not strong in manufacturing areas where employment is likely to expand in the future.

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Municipalities and cities in the Windsor-Québec City axis compete for any proposed automotive parts or assembly plants such as this Ford factory in Oakville. Foreign-owned companies may benefit from government incentives and may also gain other market advantages. However, this type of branch plant is subject to fluctuating employment levels and even permanent closing.

CONCLUSION

There are a number of highly interlinked processes underlying the various trends observed in the concentration-deconcentration of population and economic activities between the axis and the rest of the country, and in the continuing concentration of population around the four major metropolises within the axis. These processes also give some indication of the possible future course of urban expansion and contraction, and the areas where the pressure for urban land conversion will be greatest.

(1) One of the strongest influences on overall urban development is the general rate of national economic growth. Since 1951, wealth per capita has increased considerably, but the rate of growth began to diminish during the 1970s and decreased during the recession of the early 1980s. It now appears that there will be little real increase in wealth per capita during the 1980s. However, much of the increase that does occur will accrue to the axis and to the major metropolises and their surrounding urban areas.

(2) Although many factors contribute to fluctuations in the building cycle, it is apparent that building activity tends to wax and wane in roughly 25-year cycles. These long swings are affected by demographic factors, social change, interest rates, and so forth, which reinforce each other in different ways. The country is now either in, or heading out of, a trough in the building cycle, roughly equivalent in level to that of the early 1960s, but deeper with respect to the immediately preceding peak. Consequently, urban expansion will not be accelerated in the 1980s, and the only areas of rapid spread will be around the fastest growing metropolises. A trough is invariably followed by an upswing, which should occur toward the end of the 1980s. The 1990s could well be an era of catch-up, with many urban areas throughout the axis expanding outwards and creating large demands for rural-to-urban land conversion.

(3) Demographic trends will generally dampen urban growth, since the rate of natural increase will diminish rapidly because of declining fertility rates. Furthermore, net natural increase will be slightly lower in the axis than the rest of the country. The chief factor in differential regional and urban growth will continue to be net domestic migration and the general drift westwards of the population. This drift away from the core will not, however, be offset to the same degree by net foreign immigration as it was in the 1960s and 1970s. As far as the axis is concerned, the major areas of positive net total migration will be in the counties of Halton, Peel, York, and Durham around Toronto and the small area around Montréal. These will be the areas of greatest pressure on rural land in the 1980s. If there is a general upswing in the building cycle in the late 1980s, pressures around Kitchener-Waterloo and London will intensify toward the end of the decade and will also be strong around the major urban agglomerations in the axis through the 1990s.

(4) The transition to a service society suggests that most new jobs will continue to be in the tertiary sector, particularly in the business and professional service category. There has also been a dramatic increase in the participation of women in the paid labour force. Although there is some reason to believe that the pace of the transition to a service society will decrease, because the level of service employment depends on productivity in manufacturing (and agriculture), the female participation rate will continue to increase. Since service jobs are generally urban-located, and opportunities for joint employment are greatest in metropolitan areas, these trends will reinforce the tendency for economic activities and employment to be metropolitan-located.

(5) The discussion of product cycles, along with the associated importance of innovations, reveals why parts of the axis particularly dependent on rather old industries (such as the extended Cantons de l'Est, Zone mixte, and Windsor-Chatham) may continue to exhibit weakness. The metropolitan areas with more diversified industrial bases, or those concentrating on the sectors of manufacturing in which product innovation is likely to be the greatest, will probably experience the greatest growth in the future. Once again, this means the Toronto area, Kitchener-Waterloo, Montréal, and Ottawa-Hull.

Even though the general rate of urban expansion within the axis has diminished, the internal shifts in economic activity and population, which are the outcome of some basic interlocking and underlying trends, will be quite dramatic. In particular, extensive growth around Toronto and secondarily around Montréal, and in parts of southwestern Ontario, will likely continue to create severe pressures for rural land conversion in the parts of the axis that contain the best soils for agriculture. Furthermore, the levels of pressure in these areas, and around most urban agglomerations, will escalate toward the end of the 1980s with the expected upswing in the building cycle.

Niagara
PUBLIC NOTICE
TOWN OF LINCO
1970
PROPOSED SUBDIVISION
THE OLD ORCHARD PLAN
LEGEND
SEMI-DETACHED
N

URBAN GROWTH AND LAND CONSUMPTION TO THE YEAR 2001

The purpose of this chapter is to relate the trends discussed in previous chapters to the consumption of rural land for urban purposes up to the year 2001. To do this, the discussion commences by translating the economic and demographic trends into numbers in order to demonstrate the kinds of differential growth in population that may occur throughout the axis. These numbers are then converted into amounts of land that may be consumed for urban purposes in different parts of the area. Finally, there is a brief discussion of the importance of the competing demands for agricultural land within the axis.

THE DISTRIBUTION OF POPULATION AND URBAN AREAS IN THE YEAR 2001

It must be recognized at the outset that population forecasting, whether at the national or local levels, has proven to be a hazardous business in Canada. For example, forecasts in the early 1970s by Statistics Canada (1974) produced two projections of the total 1981 population that were too low (C,D), one projection that was much too high (A), and a fourth (B) that was high by only 130,000. My own forecast of the 1981 axis population (14.042 million) proved to be 840,000 too high (Yeates, 1975). It is therefore with some trepidation that the matter of future population, and the future distribution of urban growth, is considered. Past high projections occurred because of overestimates of future fertility and net foreign immigration, while low estimates resulted primarily from underestimates of net foreign immigration.

Now that the fertility rate is no longer fluctuating widely (in the short term), the accuracy of future estimates of the national population will presumably depend upon variations in net foreign immigration. Given the apparent intention of the Department of Employment and Immigration to restrain immigration, the annual average net in-flow of 86,000 per year that occurred in the 1970s will not likely be sustained and will probably be closer to 50,000 per year, or even less, during the latter half of the 1980s. A national projection produced by Statistics Canada in the late 1970s (Statistics Canada, 1979), based on an average gross fertility rate assumption of 1.7 children per woman as of 1991, and an annual net foreign immigration of 50,000 per year, would appear to provide a useful benchmark. The projection based on these assumptions yields a 1991 population of 26.55 million and a 2001 population of 28.054 million.

A major difficulty occurs when these projections are presented on a provincial basis, because the low fertility rates are swamped by high levels of inter-provincial migration. Simmons (1983*a*) comments that, for about the last 15 years, gross inter-provincial migration has been twice the amount of net natural increase. Thus a 50% increase in a province's share of total in-migration would be equivalent to doubling the rate of natural increase. He goes on to point out that since inter-provincial migration has fluctuated quite widely over the past few years (*see*, for example, Figure 11*b*), this particular factor has become exceedingly important. Unfortunately, the volatility of migration patterns imparts a strong sense of possible error to provincial projections.

The situation becomes even more complicated at the sub-provincial level. Migration to or from counties, for example, involves not only foreign immigration and long-distance domestic migration, but suburbanization and ex-urbanization as well. The rate of natural increase is not only strongly influenced by high mobility, but is also dominated in many cases by the magnitude of the migration. For example, in 41 of the 95 counties in the axis area, the total volume of net migration (disregarding the sign) exceeds that of the volume of net natural increase. Any method of forecasting populations for sub-areas within provinces, such as counties or census subdivisions, must therefore include a component incorporating total migration (both domestic and foreign).

Forecasting the Axis Population

The method used to forecast the distribution of population within the axis by the year 2001 uses the following procedure:

(1) The basic input is the demographic data for each county that has been described and analyzed in the previous chapter. For each county the information is structured as follows:

$$Pop^{1981}_{i} = Pop^{1971}_{i} + NNI^{71\text{-}81}_{i} + NM^{71\text{-}81}_{i}$$

The data cannot be reconstructed at a geo-

◀ Edward W. Manning

graphic aggregation level below that of the census division to the subdivision level, so the forecasts are for *counties* (*i*).

(2) Net natural increase (NNI) information has been assembled on the basis of births minus deaths, as described in the sources and discussion related to Map 18. The rate of NNI for each county is calculated for a time period (such as 1971-1981) as the NNI divided by the average population for the county in the decade.

(3) The rates of net natural increase for each county in one time period are used to predict the NNI for a county in the successive time period. The rates are reduced, however, by a constant factor to take into account (a) the gradual decrease in fertility rates predicted for the 1981-2001 period, (b) the general aging of the population, which means that the volume of births will begin to diminish quite rapidly after the late 1980s, and (c) the predicted decrease in foreign immigration which will also reduce birth rates. These factors will, of course, be partially offset by the increasing lifespan, though the actual effect of this factor will not be great until after the first decade of the next century. To simulate this decline in NNI rate, the rates are reduced by one-third (the average decadel trend in the decrease in the fertility rate) for each time period. Thus the 1971-1981 rates are reduced in each county by one-third to estimate the 1981-1991 NNI for the county, and again the estimated 1981-1991 rates are reduced by one-third to estimate the 1991-2001 NNI volumes.

(4) The volumes of net migration (NM) for each county comprise two basic components—domestic migration (including long-distance, suburbanization, and ex-urbanization) and foreign immigration. The previous chapter suggested that NM in each county is positively related to labour force increase (representative of economic opportunities) and negatively related to unemployment rates. NM is therefore closely linked to economic conditions. The discussion of economic trends leads to the conclusion that there will be a number of short-term inventory cycle-type swings in the economy of the 1980s. There will not be a general longer-term recovery until the late 1980s and early 1990s, when higher levels of productivity (and wealth creation) result from the extensive industrial penetration of new enabling technologies (such as micro-chips, recombinant DNA technology, and so forth). It is assumed that the decadel volume of NM experienced by counties will diminish by one-third during the 1980s, but that volumes in the 1990s will be similar to those of the 1970s, as the economy moves into an expansionary phase and the rate of unemployment decreases.

(5) The 1971-1981 NM data for each county that provides the basis for estimating future patterns preserves to a large extent the suburbanization and ex-urbanization experiences of the decade which are likely to continue into the future.

It should be re-emphasized that these procedures, or forecasting conjectures, are an attempt at transposing the previously discussed general trends into a simple set of rules that simulate the possible geographical outcome of population change.

The Axis Population in the Year 2001

The population forecasts are undertaken for each of the 95 full or partial counties in the axis, and the totals for the entire area are based on an aggregation of these local estimates. A summation of these estimates is presented in Table 20*a*, and a comparison with the selected preferred projection for Canada as a whole (with NM instead of net foreign immigration) is presented in Table 20*b*. It should be noted that while most of the figures add up correctly either because they are internally consistent (as with the projections), or because NM is estimated as a residual, the 1981 (actual) data for Canada are based on elements derived from *estimates* of foreign outmigration (see Figure 11), so there is some error in the estimate of net foreign immigration.

The Statistics Canada projection to the year 2001, which is based on data up to 1976, has underestimated the 1981 population of the country by 143,000, apparently because the average net foreign migration (NFM) between 1976 and 1981 was 25,000 higher per year than that assumed by the projection. For the 1980s, however, the assumption of 50,000 NFM per year may prove to be rather high, so the underestimation for the first five years of the projection could be compensated for by an overestimation in the 1980s. If the prediction of 28.054 million as the population of Canada in the year 2001 is accepted as reasonable on the basis of the assumptions (1.7 fertility rate, 50,000 NFM per year), then the forecast of 14.990 million people in the axis at that date can therefore be regarded as tenable. At the turn of the century, the axis could contain 53.4% of the population of the country, a modest continuation of the deconcentration of a population drifting westwards noted in Figure 4. Given that the axis contains somewhat more than half the population of the country, the

Table 20

Forecast Population Totals (000s) for the Axis, and Projected Totals for Canada, 1981-2001

(a) Axis Forecast

Year	$Pop.^{t+1}$	=	$Pop.^{t}$	+	$NNI^{(t+1),t}$	+	$NM^{(t+1),t}$
1981 actual	13,194		11,920		1,030		244
1991 forecast	14,156		13,194		801		161
2001 forecast	14,990		14,156		590		244

(b) Canada Projections

Year	$Pop.^{t+1}$	=	$Pop.^{t}$	+	$NNI^{(t+1),t}$	+	$NM^{(t+1),t}$
1981 actual*	24,348		21,569		1,897		864
1991 forecast	26,549		24,205		1,844		500
2001 forecast	28,054		26,549		1,005		500

* Does not sum, since NFM is not calculated as a residual but from separate estimates of out-migration and immigration.

Source for projections: Statistics Canada, *Population Projections for Canada and the Provinces*, Cat. No. 91-520, projection 4. 1981 actual NNI and NFM components from Figure 11.

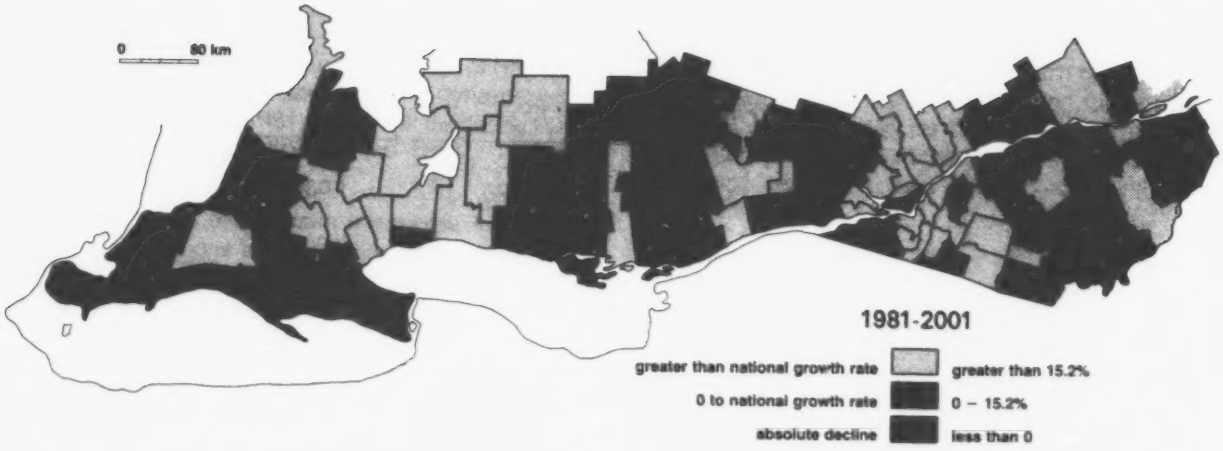
NNI component for each decade in the forecast appears to be consistent with the Statistics Canada projection, while the NM element may be on the low side.

The Distribution of Population and Urban Areas in the Year 2001

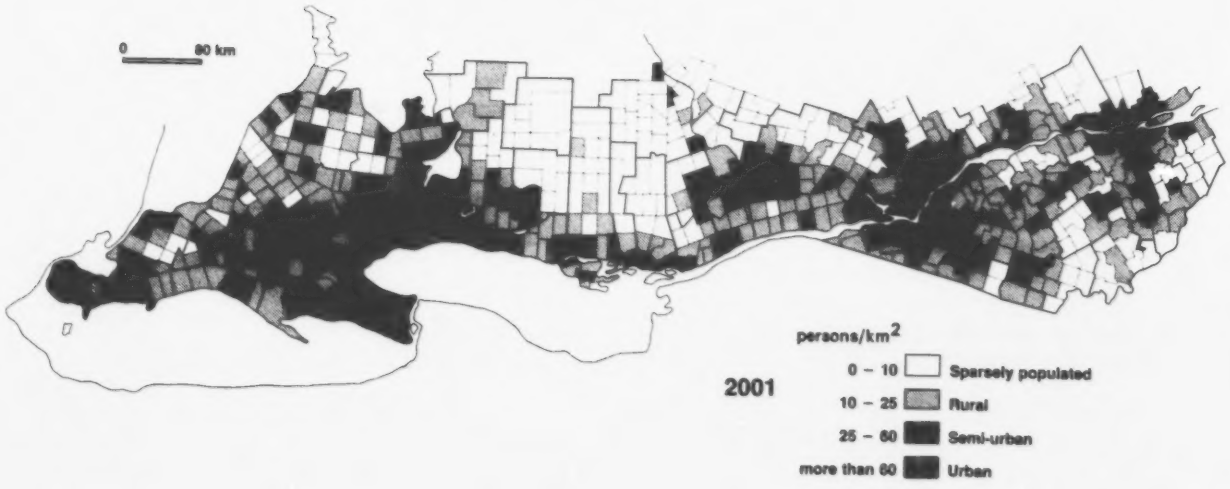
The forecast is based on county trends from 1971 to 1981, so it is not surprising that the greatest areas of forecast change are those that experienced the largest changes during the 1970s. Map 20 indicates the various rates of population increase for counties within the axis for the 1981-2001 period. The same procedure as in Maps 15 to 17 is used for defining class intervals—absolute decline, 0% to the national average increase for the 20-year period (15.2%), and greater than the national average. Because the forecasts are at the county level of aggregation, the map grossly exaggerates the geographic extent of growth. For example, the county of Pontiac in Québec exhibits a growth rate well above the national average, but this is the result of a relatively small population base combined with the high rate of suburban (and ex-urban) growth occurring in the Pontiac census subdivision adjacent to Hull.

Although this type of geographical exaggeration occurs in a number of other cases, the map emphasizes: (a) a widespread area of growth above the national average that will probably occur over a large part of the axis as the population continues its outward spread; (b) a continuing heavy population decline on Île de Montréal (-16.5%), joined in the last two decades of the century by a very small decline in population for the first time in Metro Toronto; (c) continued population decline in parts of Appalachian Québec; and (d) very large population growth in the suburbs and middle-sized urban areas adjacent to Montréal, and in an extensive area around Toronto.

Map 20
Population Growth Rates by County, 1981 - 2001



Map 21
Areas Defined as Urban, Semi-Urban, Rural and Sparsely Populated in the Windsor-Québec Axis, 2001



In terms of absolute gain or loss, the largest area of loss in axis-Québec is Île de Montréal/Île de Jésus, which could lose over 300,000 people in the 20-year period (the loss was 159,000 between 1971 and 1981), though the gain in parts of counties immediately adjacent to Montréal (Chambly, L'Assomption, Terrebonne, and Verchères) more than offsets the Montréal loss. While there are no areas of great population loss in axis-Ontario, counties of large gain around Toronto (Durham, Halton, Peel, York, and Simcoe) will be the location of 40% of the total axis 1981-2001 increase.

Map 21 shows the possible geographical extent of urban development in the year 2001. In an earlier study (Yeates, 1975), a spectral-analysis model was used to predict the future population of the axis on the basis of trends in decadel population change for 1891-1971 at the census subdivision level. The results have not proven to be satisfactory, basically because many townships exhibited two or even three periods of increase and decrease in the eight decades. Because the spectral-analysis model assumes linearity, such instability yields questionable results. Population projections at the census subdivision level have consequently been derived by using census division forecasts and allocating county population change to subdivisions in accordance with the 1951-1981 trends. The urban to sparsely-populated categories have then been defined in the same manner as in Maps 11 to 14.

Map 21 exhibits an increase in the extent of urban development along the entire Windsor-Québec City corridor. In particular, urban growth between Kitchener-Waterloo and along Lake Ontario as far east as Port Hope will be quite dramatic. Urban development northwards to Barrie and Orillia will yield not only a new continuous urban corridor, but an extensive area of suburban and "countrified" ex-urban developments. There will also be an increase in the number of census subdivisions defined as urban around Montréal and Ottawa-Hull. Densities in nearly all of the census subdivisions along the major transport corridors between Windsor/Toronto/Montréal/Québec City, St. Catharines/Hamilton/Toronto, Montréal/Ottawa-Hull, and Toronto/Orillia will have exceeded the urban threshold density.

THE FUTURE CONSUMPTION OF LAND FOR URBAN PURPOSES

The major factors generally influencing the consumption of land for urban purposes were discussed in theoretical and empirical terms in the first chapter. The increase in the number of people residing in places defined as urban is a major factor in land consumption. Table 21 demonstrates that both the number and percentage of axis population residing in subdivisions defined as urban has increased fairly continuously since 1921. Furthermore, it is forecast that in the year 2001, these urban census subdivisions will contain more than 12.6 million people, with the greatest surge in urban development occurring in axis-Ontario.

The second and third factors in land consumption offset one another to a degree. One is the tendency for people to occupy more space as the level of general wealth increases or family size decreases. This factor is usually modelled in terms of time and has been discussed with respect to Figure 1*a*. As a countervailing factor, it is also evident that large urban centres tend to have higher population densities per hectare than smaller urban areas. In other words, large urban centres use land more efficiently than smaller settlements.

So, while there is a trend for land-consumption rates (LCRs) to increase over time, because of the increased consumption per person of space that occurs with increasing wealth or decreasing family size, there is also a tendency for land-consumption rates to decrease, because with increased population there will be a proportionate increase in the population size of urban areas (*see* Figure 2*a*). It may be suggested, therefore, that although land-consumption rates will increase over time, the rate of increase will decrease because, among other things, the average population size of urban areas is in general increasing.

Chapter One indicated that a fairly long time series of good quality data on the transference of land to urban uses is simply not available. The best series (Warren and Rump, 1981) yields land-consumption rates for only three time periods. Nevertheless, since this data is collected on a reasonably consistent basis it will be used to (a) test the proposition that LCRs increase over time, but at a decreasing rate, and (b) translate the forecast increases in urban population to some estimates of the future amount of rural land that may be consumed for urban purposes.

Given the variation in the LCR information, a useful set of summary measures for the axis as a whole are the weighted LCRs listed in Table 2 for 1966, 1971, and 1976. The weighted LCRs, it will be recalled, are based on estimates of the conversion of land to urban purposes in areas *contiguous* to the larger cities and metropolises in the axis. They are estimates only of *direct* urban expansion (Smit and Cocklin, 1981). Because they are weighted means, the size and trends experienced by larger urban centres have a powerful effect on the magnitude and change in the measures. The trend in these weighted LCRs (*see* Figure 14) indicates that the weighted rate for 1981 will have been 40.9 hectares/1,000 people, and will likely be 41.8 hectares/1,000 in 1991 and 42.1 hectares/1,000 in 2001.

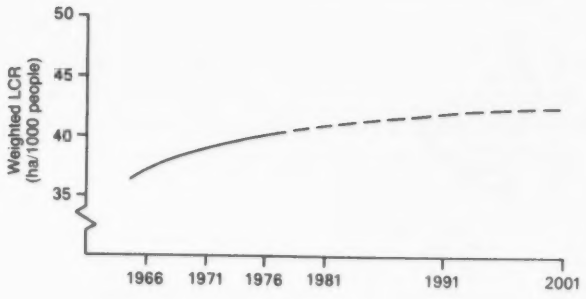
An interesting feature of the Warren and Rump data is that the areas in the axis they define as urban on the

Table 21

Axis Population (000s) and Area (km^2) in Census Subdivisions Defined as Urban, Semi-urban, Rural, and Sparsely Populated, 1921, 1951, 1971, 1981, and Forecast for 2001

Year		Sparse 0-10	Rural 10-25	Semi-Urban 25-60	Urban 60+
1921					
Area:	Ontario	42,137	45,600	12,012	4,773
	Québec	29,657	31,300	7,504	2,517
	Axis	71,794	76,900	19,516	7,280
Pop.:	Number	394	1,205	657	2,330
	Percent	8.6	26.3	14.3	50.8
1951					
Area:	Ontario	44,972	35,962	15,853	7,563
	Québec	26,029	29,284	9,859	5,968
	Axis	71,001	65,246	25,712	13,531
Pop.:	Number	388	1,029	932	4,917
	Percent	5.3	14.2	12.8	67.7
1971					
Area:	Ontario	38,914	33,873	18,058	13,677
	Québec	25,335	25,017	12,008	8,608
	Axis	64,249	58,890	30,066	22,285
Pop.:	Number	316	998	1,256	9,350
	Percent	2.7	8.4	10.5	78.4
1981					
Area:	Ontario	35,251	32,041	21,441	15,789
	Québec	25,219	22,757	12,218	10,774
	Axis	60,470	54,798	33,659	26,563
Pop.:	Number	302	930	1,259	10,703
	Percent	2.3	7.0	9.6	81.1
2001					
Area:	Ontario	32,169	31,463	19,126	21,764
	Québec	24,593	22,021	12,869	11,485
	Axis	56,762	53,484	31,995	33,249
Pop.:	Number	292	915	1,146	12,637
	Percent	2.0	6.1	7.6	84.3

Figure 14
Weighted Land-Consumption Rates, 1966, 1971, and 1976, with Projection to the Year 2001



basis of land use contain almost the same population in 1971 (9.223 million) as those defined as urban on the basis of census subdivisions in Table 21 (9.350 million). A reasonably good estimate of the amount of land in *direct* urban use in the axis in 1971 is therefore about 364 276 hectares (1971 urban population x 1971 weighted LCR). In 1981, the estimate is 10 703 x 40.9 = 437 753 hectares, and in 2001 it is 532 017 hectares. While the population of the axis will increase by 13.6% between 1981 and 2001, the amount of land consumed directly for urban purposes will increase by 21.5% during the 20-year period.

The Indirect Consumption of Land for Urban Purposes

Although the previous discussion of the direct consumption of land for urban purposes provides some useful measures, it is important to recognize that these consumption estimates completely understate the impact of urban development on rural land. There are a number of *indirect* impacts that in effect "urbanize" what appears to be rural land; some of these urban effects are exemplified by actual changes in land use, while others are represented by less visible geographic and social changes. Since there is considerable discussion in the literature of these various types of indirect impacts (Bryant, *et al.*, 1982; Simpson-Lewis, *et al.*, 1983), they will be referred to only briefly in this section.

Visible indirect land-use impacts involve: discontiguous suburban developments; strips of single detached homes along rural roads located on farm severances; various types of urban services not wanted in the city (autowreckers, sanitary land fills, dog kennels, and so forth); transport facilities (highways, airports, rail lines, gas lines); recreational facilities (Butler, 1984) for urban dwellers (motels, parks, race tracks, and so forth); and land used to generate urban resources (sand and gravel pits, nurseries, sod farms, and so forth). There are literally hundreds of urban-oriented land uses of this type adjacent to urban areas but not necessarily contiguous with them. These land uses are consequently not included in the preceding strict definition of urban land-consumption rates.

The less visible indirect impacts of urban development on rural land are, perhaps, even more pervasive. Large areas of land around major metropolises are now owned by corporations or individual landholders for speculative purposes (Martin, 1984). This land is then leased back to farmers for agriculture, but the land is clearly labelled for urban development at some future date. As a non-owner, the lessee may well exploit the land, thus debilitating the resource. Other land is owned by countrified ex-urbanite dwellers (Found and Morley, 1973) who vary in their dedication and commitment to farming and the preservation of the quality of the land (McRae, 1981).

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Transportation and communication facilities such as airports utilize large amounts of flat land that often have high capability for other uses. Selection of a site for Mirabel Airport, 64 kilometres north of Montréal, involved purchase of approximately 35 000 hectares, much of it good farmland. In 1981, the federal government initiated steps to return some agricultural land to private ownership. However, many of the original 800 farm families had left the area.

The various urban-based groups, between them, exert upward pressure on the price of agricultural land, which in turn encourages the conversion of land from agricultural purposes. If a farmer owns the land, its value can be realized at a later date, and if a farmer wishes to purchase land, the price is too high to yield an economic return in agriculture. Farms are consequently divided into smaller lots that can be sold for suburban and ex-urban developments. Smit and Flaherty (1981) note that the cumulative effect of this process is a significant change in the social structure of the rural environment.

The question that arises is whether it is possible to provide an estimate of the present and future indirect consumption of rural land for urban purposes. The area of census subdivisions defined in this study as urban for the different time periods tentatively provides an esti-

mate of the total axis land incurring both direct and indirect urban impacts. Table 22 provides a listing of the hectares influenced by the direct and indirect impacts of urban development in 1971 and 1981, with the forecast for 2001. Given the strict definition of direct impact used in this study, the direct/indirect ratio is therefore about 1:5; that is, for every one hectare of rural land in direct urban use, five hectares are are brought indirectly into urban use. It should be noted that this ratio is a great deal higher than that suggested by Krueger (1959). In this classic detailed study of the Niagara fruitbelt, Krueger estimated that for every hectare that was directly consumed for urban development, another two hectares were also spoiled for agricultural production because of the indirect impacts. The 1:5 ratio proposed in this study includes not only the land indirectly lost, but the land indirectly threatened because of non-farm ownership, high land prices, and so forth.

Urban Land Consumption and Farmland

Chapter Two noted that the area in farms in the axis decreased by 875 000 hectares between 1971 and 1981. The area devoted to farms has been declining for a number of decades, through the abandonment of land in unproductive parts of the axis and the direct and indirect impacts of urban development. Using the estimates in Table 22, it is possible that a little less than half of this loss is probably the result of the direct and indirect urban consumption of rural land. How much of the 1971-1981 decrease is irrevocably lost (that is, paved over and built on) is another question—the estimates would suggest at least 74 000 hectares.

For the last two decades of the century, the rate of loss will decrease, but will still be quite heavy. The forecasts suggest that the direct loss will be 94 000 hectares and the indirect loss 574 000 hectares, but the important issue is the location of the major losses. The greatest losses will inevitably occur in the counties that will experience the greatest population increases, because these areas will incur the largest increases in the direct consumption of land for urban purposes. Map 22 delimits those counties that will experience gains in the *direct* consumption of land for urban purposes, above the provincial average (21.5%) and more than twice the average. If this map is compared with Map 3, it is evident that the greatest pressures on rural land will be in those counties that also have the best land for agriculture in the axis. Urban development likely will directly and indirectly consume another 668 000 hectares of the better farmland between 1981 and 2001.

THE IMPORTANCE OF THE RURAL/URBAN LAND-CONVERSION PROCESS IN THE AXIS

Having presented some estimates of past, and possible future, amounts of land that have been and may be converted from rural to urban use, and the general geographic locations where such conversions might be the greatest, a question arises concerning the significance to society of the land-conversion process. The difficulty of estimating conversion rates, and hence predicting the future, should be reiterated at the outset. Good information on the amount of agricultural land lost to urban use over a long time period is not available, and the series used is limited in duration and restricted to closely-defined urban agglomerations (Warren and Rump, 1981). Furthermore, the estimates are based on predictions concerning not only trends in land-consumption rates but population as well.

Table 22

Direct and Indirect Consumption of Land for Urban Purposes (000s of ha)

				Change	
	1971	1981	2001	1971-1981	1981-2001
Direct	364	438	532	74	94
Indirect	1,864	2,218	2,792	354	574
Total	2,228	2,656	3,324	428	668

Map 22

The Forecast Percentage Increase in Direct Consumption of Land for Urban Purposes, by County, 1981-2001

For the sake of simplicity, the significance to society of rural/urban conversion will be presented in polar terms (Bryant and Russwurm, 1979). On the one hand, there are those who claim too much land is being lost to urban uses (for example, Furuseth and Pierce, 1982; Fletcher and Little, 1982), and they quote a large number of studies, and particularly the data in the Final Report of the National Agricultural Lands (NAL) Study in the United States, to support their position. On the other hand, there are those who claim that the amount of land lost to urban uses is quite small and insignificant compared with increases in agricultural productivity and the amount of land lost for such other reasons as abandonment (for example, Fischel, 1982; Simon and Sudman, 1982).

Fischel's (1982) argument is of particular interest because it relates directly to urban development in the context of a land market. Although he presents three approaches (capital utilization, natural resource depletion, and the impact of housing subsidy policies on the rural/urban fringe), the first is probably the most appropriate to the context of the axis. The *capital utilization* approach assumes that the total area for farmland is not fixed, because the geographical margins for agriculture expand and contract for varying reasons, and crops can be grown on different types of land. This is not to say that all land is of the same quality; some land is especially good for certain types of crops (or crops in general), while other land is not as good, or not suitable at all. In the axis, land that is good for crops is also in a location that is good for housing as well as urban infrastructure.

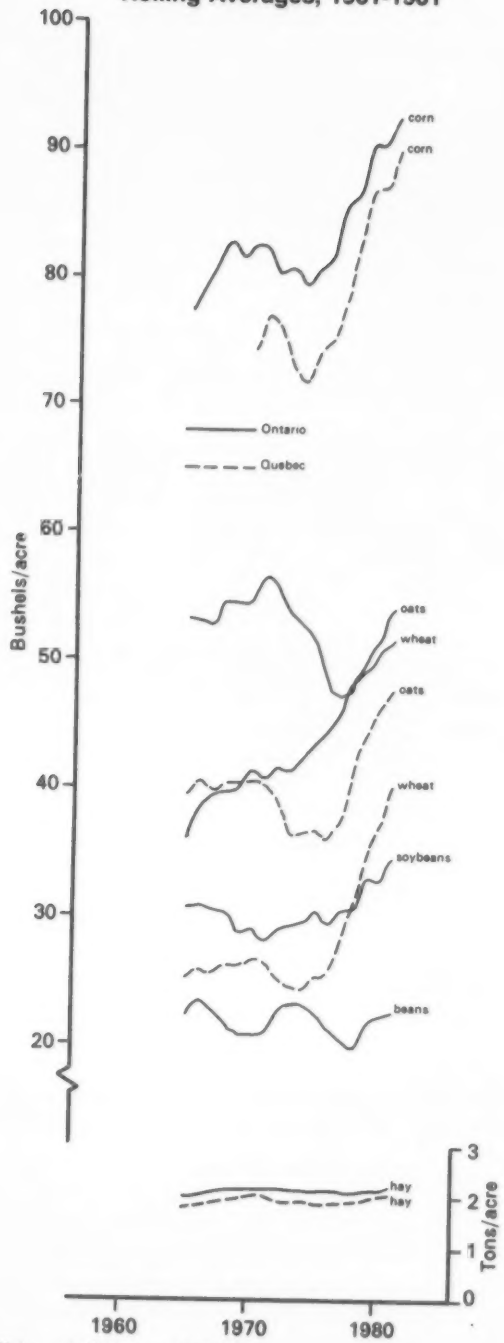
Fischel assumes two adjoining sites of equal size: site A on good land, with a value of $10,000 for use in agriculture; site B on not so good land, with a value of $4,000 for use in agriculture. If a housing developer has to choose between A and B for a development, and the costs of construction are the same on both sites, the developer will choose B because the costs will be lower. The land market in this case will guide the developer to use the land less suited for crops. This is advantageous not only to the developer but also to society, because the ensuing housing will be on cheaper land, and housing costs will be lower than if the construction was on the more expensive land A.

However, development on B usually costs more than development on A, because of the relatively greater difficulty in constructing housing and service infrastructure on poorer land. If the development costs at B are more than $6,000 greater than at A, the developer will acquire A and build there. The question that arises, of course, is whether this is detrimental to society. Assuming that building development costs at B are in fact $8,000 greater than at A, housing costs will be $2,000 cheaper if the builder acquires A, and the farmer can move to B for a gain of $6,000 and use some or all of that capital to improve the productivity of the land at B.

The advantages or disadvantages to society of allowing the developer to acquire A therefore depend upon whether (a) land and housing markets operate so as to pass the benefits of lower costs on to households, and (b) there are increases in agricultural commodity prices for consumers because of the poorer productivity of the land at B. Markusen and Scheffman (1977), in a detailed study of land and housing prices around Toronto, demonstrate that there has been no real monopoly effect on prices and that the market, on the whole, does work. High prices for land in the early 1970s appear to have been caused by unforeseen increases in the demand for

Figure 15

Trends in Yields of Various Crops in Ontario and Québec: 5-Year Rolling Averages, 1961-1981



Note: 1 bu(UK)/ac = 0.899 hl/ha
This metric conversion can be used but is not common and therefore has not been utilized in this figure. Because of the different crop weights, the more familiar kg/ha cannot be used in this instance.

Sources: Statistics Canada, Cat. No. 22-002 and 21-003.

land for housing, a shortage of trunk-line water and sewage service capacity, and a slow rate of approval for housing developments in some areas. Furthermore, provincial government policies relating to land-use control in Ontario and Québec have had little real effect on the pace and geographical direction of urban development (Frankena and Scheffman, 1980; Gaylor, 1982; and Troughton, 1984), and construction of limited-access highways has actually stimulated growth in particular directions.

If it is accepted that, on the whole, land and housing markets do pass lower costs on to the consumer, then the second part of the issue relates to whether the consumption of better quality land for housing, and some of the indirect impacts of urban land consumption, have resulted in decreasing agricultural productivity in Ontario and Québec and hence in higher prices to consumers. This is an extremely difficult issue to address, because, as demonstrated in Chapter Two, agriculture in the axis is mostly directed toward the production of high value/hectare commodities, such as dairy products, livestock, vegetables, and various kinds of fruit. Because much of the land is used to produce feed for the dairy, beef, pig, and other livestock industries, information concerning yields can cast some light on this question.

Figure 15 plots the five-year rolling averages of yields per unit area for various crops over the past two decades. First of all, yields are noticeably always higher for every crop, on the generally better land and in the more equable climate, in axis-Ontario than in axis-Québec. The shift of population to the western part of the axis is therefore placing greater pressure on land in the better agricultural environment of southern Ontario. However, average levels of productivity for most crops within the axis generally increased considerably during the late 1970s, following some declines in the late 1960s and early 1970s. The reasons for these recent large increases in productivity probably have to do with newer high-yielding hybrids, irrigation, and the need to generate greater revenue per hectare to cover high interest rates and rapidly increasing energy and fertilizer costs in the late 1970s. It is interesting to note in this context (*from* Table 3) that, while axis farm cash receipts (in constant 1971 dollars) actually declined from $211.15 per hectare in 1961 to $195.20 per hectare in 1971, they increased to $340.81 per hectare in 1981.

These fragments of information therefore suggest that farm productivity has been increasing in recent years, following a decline in the early 1970s. But, with the continued increase in domestic and foreign demand for agricultural products, it is important to speculate briefly on how long these increases in productivity can be maintained. There is no doubt that most efforts to

improve yields extract a heavy toll from the fabric of the soil (Standing Senate Committee on Agriculture, Fisheries and Forestry, 1984). This toll is cumulative, and maintaining high yields requires the utilization of more demanding hybrids, more fertilizer, and more artificial growth stimulants (for both plants and animals). The time will therefore come when additional inputs may well produce small or no improvements in yields, and output per hectare may stabilize and even decrease. This time, if it is not now at hand, will probably be reached in the axis well before 2001.

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Most of the cities in the Windsor-Québec City axis are situated on high capability agricultural land, so their expansion threatens some of the most productive foodlands in Canada. Land-use monitoring studies across Canada indicate that 57% of all rural land converted to urban uses between 1966 and 1981 was prime farmland (CLI Classes 1-3). Rates for individual cities include: London (99%), Chatham (98%), Toronto (97%), St. Jean (96%), Windsor (93%), Oshawa (91%), Montréal (74%), Ottawa-Hull (55%) and Québec City (37%).

CONCLUSION

The urban consumption of rural land in the Windsor-Québec City axis is already extensive, and over the next few decades even more land will be converted to urban uses. Furthermore, most of this land will be of superior quality for agriculture. Present agricultural yields will be difficult to sustain in the future, so the loss of more productive land will generate social costs in terms of increased prices for foodstuffs. The rural-to-urban land-conversion issue is, in reality, one of trade-offs. It is necessary to maintain constant vigilance over the type and location of land involved in rural/urban conversion and over the mechanisms through which the process of use change occurs.

In particular, this study demonstrates the need for the following kinds of research, information gathering, or analysis of policy alternatives:

(1) Monitoring land-use change in large urban regions must continue to be a high priority. Information is only available for recent decades, and much of this lacks consistency and continuity. The CLUMP (Canada Land Use Monitoring Program) effort is well-conceived, produces information superior to that in most other countries, and should be continued.

(2) Emphasis should continue to be placed on analysis of the processes involved in land-use change in the rapid growth areas of southern Ontario surrounding metropolitan Toronto and, to a more limited geographical extent, around Montréal. The greatest pressure on good quality land will undoubtedly occur in the rapid growth areas of axis-Ontario, and this pressure will escalate through the late 1980s into the 1990s.

(3) Some mechanism should be developed for estimating the *indirect* consumption of rural land for urban purposes and the impact that this type of consumption has on the land resource. The information available pertains only to the direct consumption of land for urban purposes and largely underestimates the impact of urban development on agricultural land.

(4) More detailed cost/benefit analysis needs to be undertaken on the relative social value of the urban or agricultural use of different types of land in various geographical locations that may be used for urban purposes. For example, although the loss of some of the fruitlands in the Niagara Peninsula (Krueger, 1982) has been the subject of many studies, much public

debate, and many attempts at initiating planning controls, it is not at all clear that a public consensus on the value of these lands has emerged. This may well be because the issue has not been examined with respect to the medium-term (10-15 years) costs and benefits that might result from different land uses.

(5) Various procedures for enhancing the operation of the land market should be investigated, and the most appropriate procedures implemented. For example, the capital utilization approach that has been discussed suggests consideration of a "development rights" market as mentioned by Frankena and Scheffman (1980). In such a market, for example, the local government would estimate on the basis of forecasts how much land would be needed for development over a period of time and would then, in public auction, allocate "rights to develop" to land owners. In theory, the owners of less fertile and cheaper land would, if their development costs were reasonable, be better able to bid for the rights to develop than the owners of the more fertile land. Owners of the cheaper land could bid more because their potential profits would be greater. There would, no doubt, be cases where the better land would have to be used, and in such instances a "development rights" market would provide a means for identifying this land at an early stage in the rural/urban conversion sequence and would offer cash compensation.

This study demonstrates that the urban consumption of rural land is a continuing issue of vital importance within the axis. Although analysis has been undertaken in as logical a fashion as possible, it should be clear that much of the information required for projecting future use is quite tenuous. Nevertheless, the methods used provide an approach for dealing with a problem that will persist, and will become even more significant as the population not only of Canada, but more vitally, of the entire world increases. Our stewardship of the land resource is of international as well as national importance.

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